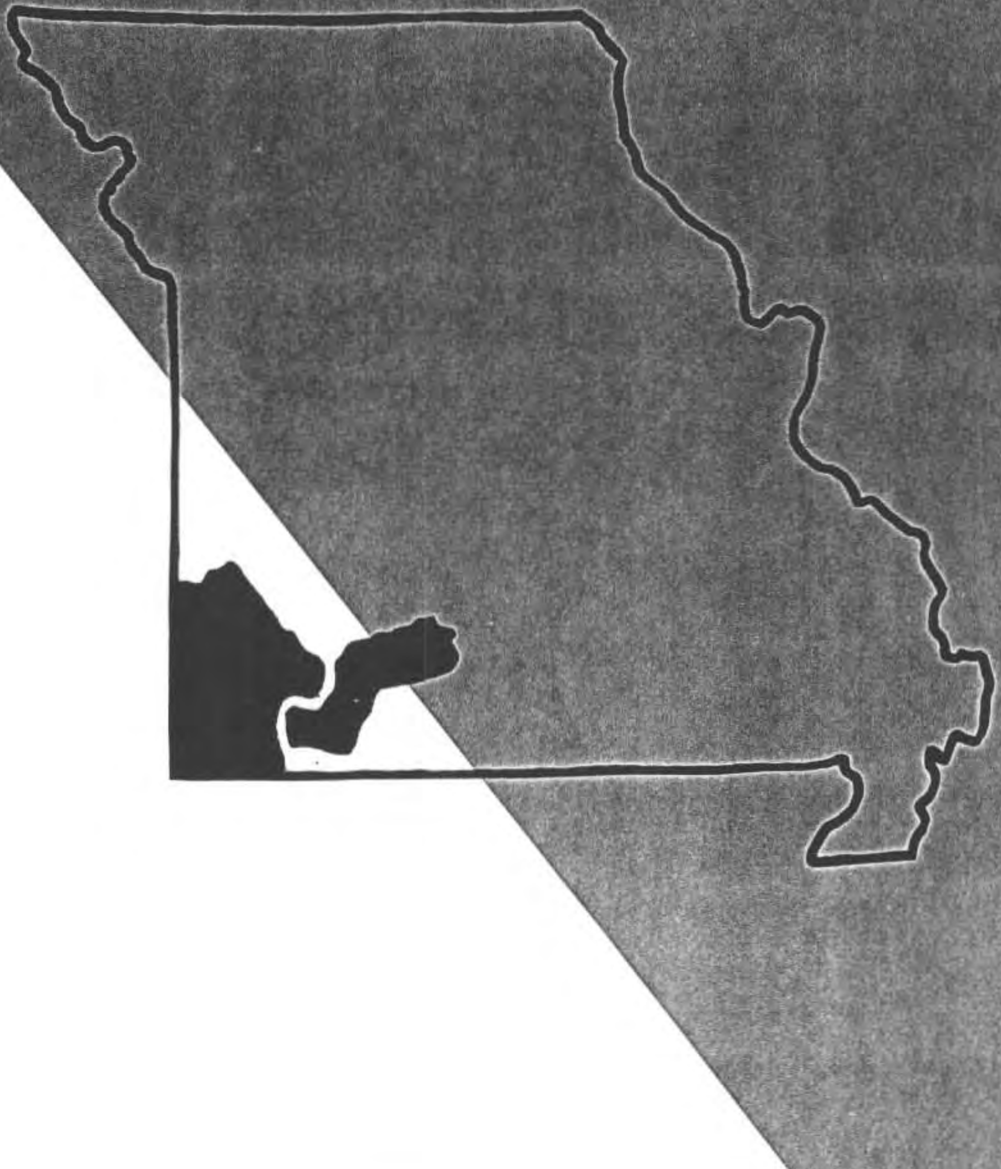
Water Quality



JAMES
ELK
SPRING
RIVER BASINS

1973

Missouri Clean Water Commission
P. O. Box 154 Jefferson City, Missouri 65101

WATER QUALITY

of

JAMES, ELK AND SPRING
RIVER BASINS

1964-1965

Missouri Geological Survey and Water Resources

Missouri Department of Conservation

Missouri Clean Water Commission

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May 22, 1973

The Honorable Christopher S. Bond
Governor of Missouri
Jefferson City, Missouri

My dear Governor Bond:

Herewith is the Missouri Clean Water Commission's second published report on water quality.

The collection of the data and compilation of this report was made possible through the cooperation of the Missouri Department of Conservation, the Missouri Division of Geological Survey and Water Resources, the U.S. Geological Survey, the Environmental Protection Agency, and members of our staff.

The information contained in this report is basic to the development of the James, Elk and Spring River Basins. Your interest and that of the Legislature has made this study possible.

Very truly yours,

Theodore G. Scott
Chairman
Missouri Clean Water Commission

APPENDICES

Certain tables, maps and data were proposed to be published separately as appendices. In the final preparation of the report, it was deemed more appropriate to include the tables and figures, intended to be published as Appendix "A" and "B", in the body of the report. The raw basic data is published in separate document as follows:

Water Quality of James, Elk, and Spring River Basins

Appendix C - Biological Data

Appendix D - Water Quality Data

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I. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary:

The Stream Survey of the James, Elk, and Spring River Basins was started in the summer of 1964 and completed in the summer of 1965. Fifty-two stations were sampled throughout the three basins. Samples were collected once during each season of the Stream Survey. Several water quality parameters which require immediate analysis were measured at each station in a mobile laboratory used during the survey.

The James, Elk, and Spring River Basins cover over 4,000 square miles in the southwestern corner of Missouri. The North Fork of the Spring River differs from the rest of the study area in that it is classed as a prairie stream. The remainder of the Spring River and its tributaries plus the Elk and James Rivers and their tributaries are more typical Ozark streams.

The geologic structure of the area results in much intersection of surface and groundwater. Base flows in all but the northern portion of the Spring River Basin are well maintained by groundwater inflow and spring discharges.

The importance of the mineral resources of the area has diminished in recent years.

Recreational use is high in all three basins. The clear, fast-moving waters typical of these streams attract many visitors. High aesthetic values are also associated with these streams.

Water supplies are provided primarily by potable groundwater sources. A few cities, for example, Joplin and Springfield, use surface water supplies as their primary source or as an auxiliary supply.

Municipal and industrial discharges are located in all three river basins. In the James River Basin, municipal wastes contribute the largest volume discharged. In the Spring River Basin, discharges from both municipal and industrial sources are significant, while in the Elk River Basin industry is the major contributor of wastes.

Guaging measurements showed that Wilson Creek loses and gains flow at various points due to the Karst topography of the area. With the exception of wet weather streamflows, the discharge from the Southwest Sewage Treatment Plant at Springfield provided nearly 100% of the low flow in Wilson Creek.

Dissolved oxygen was depressed in Wilson Creek and in Rader Spring downstream from the Springfield Southwest Sewage Treatment Plant. This adversely affected several of the James River stations downstream from the Wilson Creek confluence during certain seasons. Oxygen concentrations were periodically depressed for at least 14 miles downstream from the mouth of Wilson Creek. The James River appeared to improve downstream from J-6 with higher oxygen concentrations observed further downstream at J-7 and J-8.

High concentrations of nitrogen and phosphorus were found in the Wilson Creek samples. Most of the nitrogen was in the form of ammonia, a decomposition product of sewage which is toxic to aquatic life.

Coliform bacteria counts were highest in the Wilson Creek portion of the James River Basin. Significant concentrations also were found in Finley Creek at Jf-3 below Ozark, Flat Creek at Jfl-1 below Cassville, and Pearson Creek at Jp-1.

Very little variation was found in any of the chemical and bacteriological parameters analyzed at the Elk River Basin sampling stations. The coliform concentration was slightly higher than normal in Indian Creek at Ei-2 during the summer survey.

In the Spring River Basin, Center Creek at times showed the highest concentration of pollutants. The inflow of pollutants from Grove Creek into Center Creek lowered the pH, increased the specific conductance by 200 to 300 micromhos, and increased the concentration of sulfates, phosphates, manganese, cilica, sodium, and fluoride. In the downstream area specific conductance and sulphates continued to increase, whereas the other parameters gradually moved toward the normal range.

The alkalinity and the degree of mineralization of surface waters were lower in the North Fork of the Spring River than in the other tributaries.

Conclusions:

The water quality of the upper James River was generally good as indicated from samples taken from J-1 through J-4. Certain parameters investigated on Pearson Creek, Jp-1, and Sequiota Creek, Js-1, create some suspicion. Nitrates were consistently high on Pearson Creek and coliform bacteria numbers were high during one low flow season. Data from benthic collections on Sequiota Creek showed a disturbed condition. Seepage from septic tank-tile field systems on the east side of Springfield entered sinkhole areas which supply groundwater flow into these two creeks. The benthos in Sequiota Creek appeared to be affected by sedimentation from industrial sources.

The water of Wilson Creek was polluted by the discharge from Springfield's Southwest Sewage Treatment Plant. The effect of Wilson Creek on James River extended for a considerable distance. Stations J-5 and J-6 (14 miles below the mouth of Wilson Creek) during low flow periods showed the direct adverse effects of abundant organic wastes, for example, depression of dissolved oxygen, high ammonia, excessive nutrients and increased specific conductance. Stations J-7 and J-8 consistently had supersaturations of dissolved oxygen during daylight sampling periods. This was produced by heavy growths of filamentous algae at these points which were believed to be due to nutrient material from Wilson Creek.

The quality of surface water and groundwater in the Wilson Creek area is greatly influenced by the Karst topography common to the area. Wilson Creek loses and gains a substantial quantity of flow at times. The water of Rader Spring was polluted due to influence of the treatment plant effluent and the geological formations in the area.

A portion of Finley Creek below the City of Ozark was polluted by untreated wastes from a cheese processing industry. The discharge from the sewage treatment facility serving the City of Ozark added significant coliform bacteria concentrations to Finley Creek. These effects on Finley Creek were diminished, for the most part, at Jf-4, approximately seven miles downstream from the City of Ozark.

The two remaining tributaries of significant size in the James River Basin, Crane Creek and Flat Creek, were generally of good quality at their confluence

with the James River. The sampling stations on these creeks below the cities of Cassville and Crane showed slight evidence of receiving any wastes and these effects extended for only a short distance downstream.

The water quality of the Elk River with one exception was excellent. Although several industrial waste discharges are found in this basin, they are at points where they are rapidly assimilated by the receiving stream. Ei-2 was the only station showing evidence of waste discharges. This was indicated by a slight elevation in coliform numbers and a disturbance in the benthic community at that point.

The water quality of the upper reaches of the Spring River at stations S-1 and S-2 was affected by periodic discharges from industrial sources. The benthic data at S-2 had some unusual characteristics which varied with the season. The winter collection contained very few clean water organisms, while the spring and summer data indicated good water quality. S-3 was affected bacteriologically by the small stream receiving a discharge from the City of Aurora during the winter and spring surveys. These were the only periods in which this small creek from Aurora carried any flow.

Spring River at stations S-4 and S-5 consistently had high quality water. Williams Creek, Sw-1, which entered upstream from S-4 had little effect upon the main stem of the Spring River. Williams Creek receives municipal and industrial waste discharges from the City of Mount Vernon and was polluted by these discharges during low flow periods.

The discharge from the sewage treatment facility of the City of Carthage plus turbid industrial wastes combined to lower the water quality of the Spring River at station S-6. High bacteria concentrations which resulted from the municipal discharge, were found here; increased turbidity readings were attributable to the industrial discharge near Carthage. These two factors combined to lower the number of types of macroinvertebrates found at this point. Good water quality was found at the downstream Spring River stations, S-7 and S-8.

The North Fork of the Spring River is a prairie type stream that receives the lagoon discharge from the City of Lamar. During low stream flows the lagoon discharge has a noticeable effect upon Snf-2.

Overland runoff is the chief source of water in the North Fork of Spring River. The water of the North Fork of the Spring River was more turbid than the water in the other streams in the Spring River Basin, due to more intensive agriculture activities and the prairie type setting. Very little flowing groundwater is present, resulting in low alkalinity and low specific conductance.

Center Creek downstream from the entrance of Grove Creek was seriously polluted. Discharges from an industrial complex along Grove Creek were found to contain high concentrations of ammonia which created a significant oxygen demand in Center Creek. Other parameters which were altered significantly were pH, alkalinity, specific conductance, phosphates, sulfates, silica, and fluoride. Mine water influenced the water quality of Center Creek at stations further downstream. Seepage of groundwater into Center Creek at various points downstream from Sc-5 accounted for the steady increase in specific conductance, sulfates and heavy metals.

Benthic invertebrate populations at stations Sc-4, through Sc-8, a distance of 18 miles, indicated the severe impact of the waste discharges and mine water inflows at Sc-5 through Sc-6. The seepage plus the discharges associated with Grove Creek were thought to be toxic to bacterial growths. A raw sewage discharge from the City of Carterville plus treated wastes from Webb City should have caused a great increase in coliform numbers at several downstream Center Creek stations; however, no significant increase was observed.

Shoal Creek and Turkey Creek, which were sampled only briefly, showed little or no change in the water quality from that found in a 1958-59 study.

The discharge from Joplin's Turkey Creek Sewage Treatment Plant provides practically all the flow in Turkey Creek with the exception of high stream flows. Consequently, Turkey Creek below the plant's discharge was severely polluted.

The water quality of Shoal Creek was generally high with only slight variations, caused by waste discharges, in a few parameters. The two largest discharges to Shoal Creek, municipal wastes from the City of Neosho and from a sewage treatment plant serving a portion of Joplin, are small compared to the flow in Shoal Creek and are quickly assimilated.

Recommendations:

As a result of the stream survey, certain problems were recognized and more clearly defined. From the understanding and recognition of these problems the following recommendations are suggested:

James River Basin:

1. The City of Springfield should proceed, on schedule or at an earlier date, with the order handed down by the Clean Water Commission on May 10, 1972 in order to comply with the established Water Quality Standards for the James River.
2. The City of Springfield should proceed with extending sewer service to adequately match the City's growth. Of prime concern are areas presently on septic tank-tile field systems in areas associated with Karst topography.
3. Recognizing that Finley Creek immediately downstream from the City of Ozark is used extensively for recreational purposes, the City of Ozark and Major Cheese Incorporated should take steps to insure this reach of Finley Creek complies with the established Water Quality Standards.

Elk River Basin:

1. The industry which now discharges to the Elk River Basin from inadequate treatment facilities should develop and implement measures to provide adequate treatment for their wastes or eliminate their discharge.

Spring River Basin:

1. The industrial complex presently discharging to Center Creek via Grove Creek should develop and maintain a rigorous program for the elimination of water quality problems in Center Creek associated with its discharges in order to comply with established Water Quality Standards.
2. The use of, and subsequent discharge of, mine water in the portion of the tri-state lead belt area near Center Creek should be discouraged.
3. Industry involved in any process which would create a discharge containing any metal wastes should be discouraged from locating in the Center Creek watershed or any other area suspected of being connected to the Center Creek watershed by groundwater inflow.

II. INTRODUCTION

II. INTRODUCTION

PROGRAM OBJECTIVES

Certain objectives were incorporated with the establishment of the Stream Survey Program. These objectives were designed to reveal the natural water quality and quantity, man's influence on these parameters, and means of maintaining or improving water quality for all legitimate water uses of both the present and the future.

Specifically these objectives are:

1. To determine the extremes or range of quantity, the increment of ground flow in total stream quantity, the pattern of availability and mass movement of water in the stream, and the loss of stream flow to underground aquifers.
2. To determine the present water use and the anticipated use as to the future quantity and quality requirements for municipal water supplies, sewage disposal, industrial use, recreational use, fish and wildlife, agriculture and other beneficial uses.
3. To establish trends of chemical, physical and biological characteristics of the water, as peculiar to the geological formations and the physical characteristics, both natural and man-made for each of the various stream basins.
4. Through the initial survey and continuous monitoring, establish changes in the characteristics of the water due to pollution.
5. To compile data on the effects of various waste discharges upon the stream under different natural conditions for pollution abatement needs.
6. To locate and evaluate waste discharges to the stream to insure compliance with established water quality standards.
7. To collect data useful to municipal, industrial, agricultural, recreational, fish and wildlife, individual, and all other legal users.
8. To procure stream data and conduct public meetings to determine local sentiment as to the beneficial uses for which the stream should be preserved.

IMPLEMENTATION

Personnel

Two engineers are assigned to the Stream Survey Program under the section of Stream Surveys and Industrial Wastes. The collection and analysis of samples is the responsibility of one of the engineers. This engineer is also responsible for the preparation and shipment of samples requiring special analyses to the

United States Geological Survey, Water Quality Branch, Little Rock, Arkansas, when such data are required.

Under the Water Quality Section of the Missouri Department of Conservation two aquatic biologists are involved in the Stream Survey Program. The collection and identification of the benthic organisms is the responsibility of one of these biologists.

Stream flow measurements are made at the time of sample collection by a hydraulic engineer from the United States Geological Survey, Surface Water Branch, Rolla, Missouri. This hydraulic engineer is furnished through the Missouri Geological Survey by an agreement between the two agencies.

Sampling

The selection of sampling stations is done in a manner which best shows stream characteristics, both natural and man-made. Certain criteria used in the individual selections are:

1. At or near waters used for municipal, industrial, agricultural, and fishing and recreational purposes.
2. Above all known sources of waste discharges.
3. At points below known sources of waste discharge to reflect any changes in water quality.
4. Near state boundaries to determine the quality of waters entering or leaving the state.

Where it is possible, sampling stations are located at flow gauging stations established and operated by the United States Geological Survey.

The collection of the samples for chemical and physical analyses were made by the methods described in Standard Methods for the Examination of Water and Wastewater, 12th edition, 1965. Ample volumes of sample water are collected. A portion of this is preserved to be used in the central laboratory for certain analyses while the other is left untreated for field analyses in the mobile laboratory and also for several analyses to be made in the central laboratory which do not require preservation.

The surveys are scheduled such that the stations in each basin may be sampled during each season of the year.

Each stream survey is divided by the most suitable method possible to allow for the collection of samples in the maximum of a five-day work period. In the case of the James, Elk and Spring Stream Surveys, two weeks were required for the collection of all the samples. The Spring River Basin was sampled in a one week period and the Elk and James River Basins were combined and sampled in a five-day week. Sampling station locations and descriptions are found in Figures II-1, 2 and Tables II-1, 2.

Analyses

With the aid of the mobile laboratory,the parameters which are normally subject to rapid degradation,can be analyzed immediately after collection.

The analyses which are produced at the sampling station are:

1. Temperature
2. pH
3. Alkalinity
4. Dissolved Oxygen
5. Nitrite - Nitrogen
6. Specific conductance
7. Total Hardness
8. Calcium Hardness
9. Total Coliform
10. Fecal Coliform
11. Fecal Streptococcus
12. Turbidity
13. Stream Flow (U.S.G.S.)

The remainder of the parameters are analyzed in the central laboratory after completion of each survey. A complete listing of all the analyses performed is found in Appendix D.

When the presence of certain metallic ions is suspected, i.e., lead, zinc, chromium, etc., a special sample is collected, preserved and shipped to the U.S. Geological Survey, Water Quality Branch, Little Rock, Arkansas, for analysis.

FIGURE II - I
SAMPLING STATIONS
JAMES RIVER BASIN

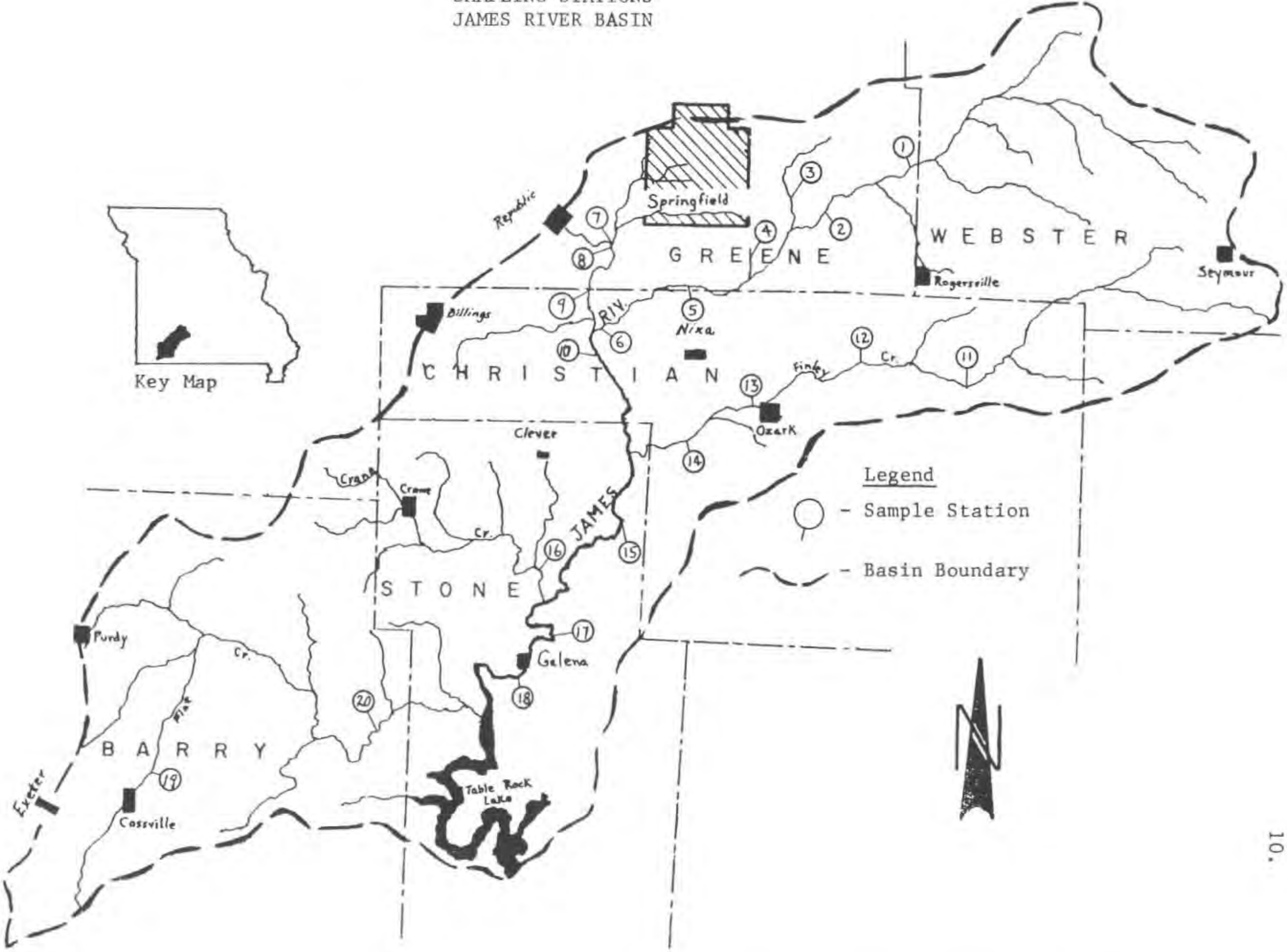

FIGURE II - 2
SAMPLING STATIONS
ELK AND SPRING BASINS

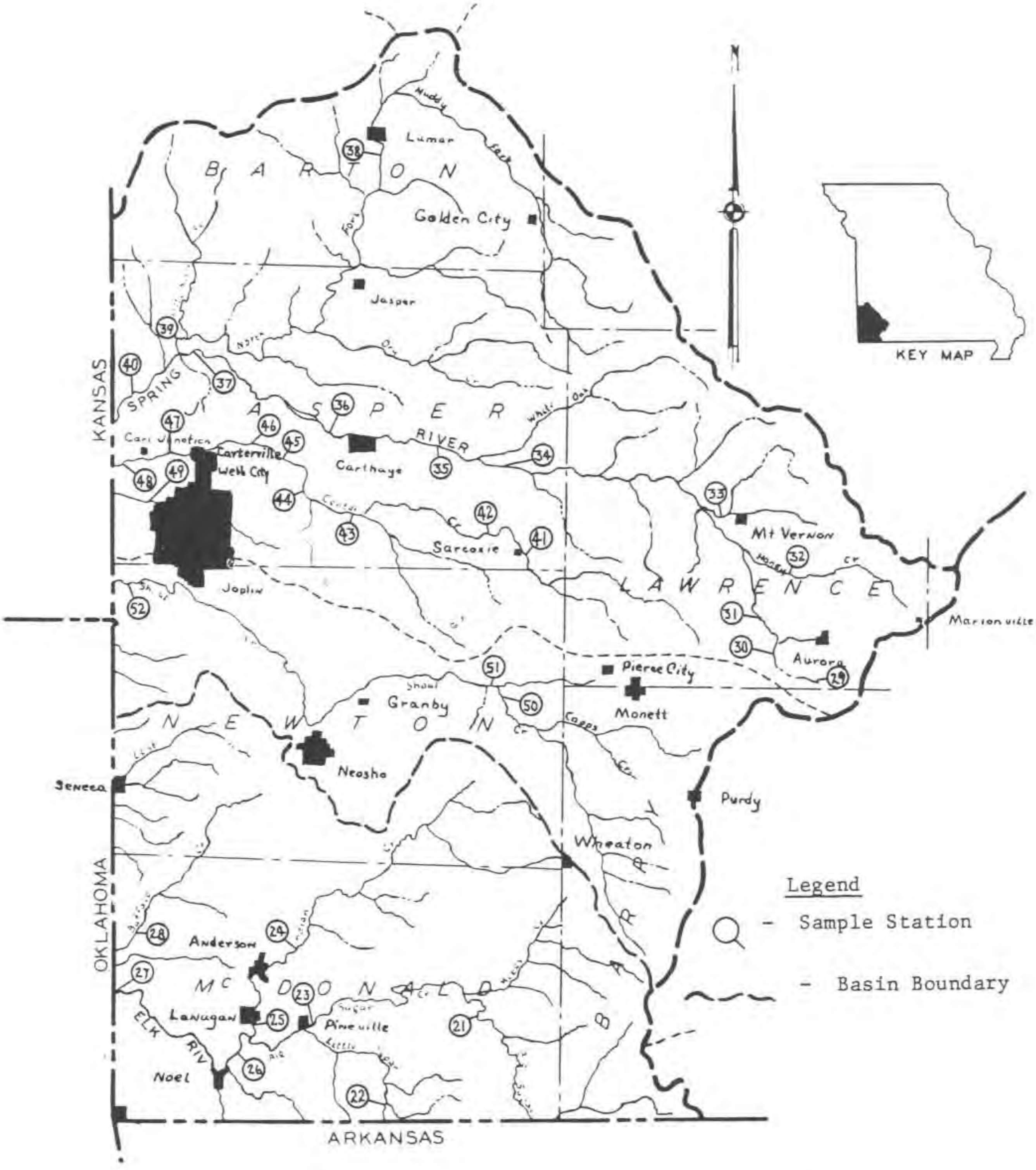

TABLE II - 1
SAMPLING STATION LOCATIONS
JAMES, ELK, AND SPRING BASINS

James River Basin

STATION	MAP NO.	STREAM MILE	COUNTY	DESCRIPTION
J-1	1	550-103	Greene	Approximately 150 ft. upstream from a county road bridge, Sec. 24, T29N, R20W.
J-2	2	550-97	Greene	Approximately 500 ft. upstream from Highway "D" Bridge, Sec. 31, T29N, R20W.
Jp-1	3	550-94-1	Greene	Approximately 75 ft. downstream from Highway "D" Bridge, Sec. 35 T29N, R21W.
Js-1	4	550-90-0.5	Greene	Under Highway "60 and 65" Bridge, Sec. 16, T28N, R21W.
J-3	5	550-86	Greene	Approximately 300 ft. upstream from Highway "160" Bridge, Sec. 26, T28N, R22W.
J-4	6	550-79	Christian	Approximately 300 ft. downstream from a county road bridge, Sec. 6, T27N, R22W.
Jw-1	7	550-77-5	Greene	Approximately 1,000 ft. downstream from a county road bridge, Sec. 18, T28N, R22W.
Jwsp-1	8	550-77-5	Greene	Approximately 150 ft. downstream from a county road bridge, Sec. 26, T28N, R23W.
Jw-2	9	550-77-1	Christian	Approximately 100 ft. downstream from a county road bridge, Sec. 1, T27N, R23W.
J-5	10	550-70	Christian	Approximately 300 ft. upstream from a county road bridge, Sec. 32, T27N, R22W.
Jf-1	11	550-67-21	Christian	Approximately 300 ft. downstream from a county road bridge, Sec. 14, T27N, R20W.
Jf-2	12	550-67-18.5	Christian	Approximately 60 ft. downstream from Highway "125" Bridge, Sec. 16, T27N, R20W.

James River Basin (cont.)

STATION	MAP NO.	STREAM MILE	COUNTY	DESCRIPTION
Jf-3	13	550-67-12	Christian	Approximately 300 ft. upstream from Highway "65" Bridge, Sec. 27, T27N, R21W.
Jf-4	14	550-67-6	Christian	Approximately 100 ft. downstream from Highway "160" Bridge, Sec. 1, T26N, R22W.
J-6	15	550-60	Stone	Approximately 300 ft. downstream from a county road bridge, Sec. 19, T26N, R22W.
Jc-1	16	550-50-0.5	Stone	Approximately 120 ft. downstream from Highway "AA" Bridge, Sec. 21, T25N, R23W.
J-7	17	550-48	Stone	Along Highway "AA" in the southwest quarter of Sec. 21, T25N, R23W.
J-8	18	550-36	Stone	West 0.7 mile on Highway "148" from Galena Square then south 1.9 miles on a gravel road, Sec. 14, T24N, R23W.
Jf1-1	19	550-27-43	Barry	Approximately 50 ft. upstream from a county road bridge, Sec. 10, T23N, R27W.
Jf1-2	20	550-27-13	Barry	Approximately 600 ft. upstream from Highway "EE" Bridge, Sec. 34, T24N, R25W.

Elk River Basin

STATION	MAP NO.	STREAM MILE	COUNTY	DESCRIPTION
Ebs-1	21	114-36-18	McDonald	Approximately 100 ft. downstream from Highway "E" Bridge, Sec. 16, T22N, R30W.
Els-1	22	114-36-12	McDonald	Approximately 100 ft. downstream from State Highway "71" Bridge, Sec. 34, T21N, R31W.
E-1	23	114-36	McDonald	Approximately 150 ft. downstream from Highway "71" Bridge, Sec. 34, T22N, R32W.
Ei-1	24	114-31-8	McDonald	Approximately 100 ft. downstream from Highway "76" Bridge, Sec. 18, T22N, R32W.

Elk River Basin (cont.)

STATION	MAP NO.	STREAM MILE	COUNTY	DESCRIPTION
Ei-2	25	114-31-1.5	McDonald	Approximately 1,000 ft. upstream from Highway "71" Bridge, Sec. 25, T22N, R33W.
E-2	26	114-39	McDonald	Floyd Kirk farm along Highway "59", Sec. 1, T21N, R33W.
E-3	27	114-16	McDonald	Approximately 50 ft. downstream from Highway "43" Bridge, Sec. 22, T22N, R34W.
B-1	28	1 mile in Missouri	McDonald	Approximately 150 yds. downstream from Highway "43" and "76" Bridge, Sec. 4, T22N, R34W.

Spring River Basin

STATION	MAP NO.	STREAM MILE	COUNTY	DESCRIPTION
S-1	29	131-113	Lawrence	Approximately 50 ft. upstream from Old Highway "60" Bridge, Sec. 20, T26N, R26W.
S-2	30	131-110	Lawrence	Approximately 30 ft. upstream from a county road bridge, Sec. 8, T26N, R26W.
S-3	31	131-108	Lawrence	Approximately 200 ft. downstream from a county road bridge, Sec. 6, T26N, R26W.
Sh-1	32	131-102-0.5	Lawrence	Approximately 75 ft. upstream from a county road bridge, Sec. 2, T27N, R27W.
Sw-1	33	131-98-3	Lawrence	Approximately 150 ft. downstream from a county road bridge, Sec. 26, T28N, R27W.
S-4	34	131-94	Lawrence	Approximately 25 ft. upstream from Highway "97" Bridge, Sec. 13, T28N, R28W.
S-5	35	131-76	Jasper	Approximately 200 ft. upstream from a county road bridge, Sec. 4, T28N, R30W.
S-6	36	131-67	Jasper	Approximately 300 ft. downstream from a county road bridge, Sec. 31, T29N, R31W.

Spring River Basin (cont.)

STATION	MAP NO.	STREAM MILE	COUNTY	DESCRIPTION
S-7	37	131-54	Jasper	Approximately 450 ft. downstream from a county road bridge, Sec. 3, T29N, R33W.
Snf-2	38	131-53-27	Barton	Under Highway "71" Bridge, Sec. 13, T31N, R31W.
Snf-3	39	131-53-1	Jasper	Approximately ½ mile downstream from confluence of the Little North Fork Spring River, Sec. 4, T29N, R33W.
S-8	40	131-47.5	Jasper	Approximately 1,300 ft. downstream from a county road bridge, Sec. 26, T29N, R34W.
Sc-1	41	131-36-36	Jasper	Approximately 200 ft. downstream from Highway "166" Bridge, Sec. 9, T27N, R29W.
Sc-2	42	131-36-32	Jasper	Approximately 300 ft. upstream from Highway "37" Bridge, Sec. 1, T27N, R30W.
Sc-3	43	131-36-20	Jasper	Approximately 300 ft. downstream from a county road bridge, Sec. 32, T28N, R31W.
Sc-4	44	131-36-16	Jasper	Approximately 100 ft. upstream from Highway "HH" Bridge, Sec. 24, T28N, R32W.
Sc-5	45	131-36-12.5	Jasper	Approximately 450 ft. downstream from a county road bridge, Sec. 10, T28N, R32W.
Sc-6	46	131-36-9	Jasper	Approximately 75 ft. upstream from a county road bridge, Sec. 1, T28N, R33W.
Sc-7	47	131-36-6	Jasper	Approximately 300 ft. downstream from Highway "171" Bridge, Sec. 9, T28N, R33W.
Sc-8	48	131-36-1	Jasper	Approximately 600 ft. downstream from a county road bridge, Sec. 14, T28N, R34W.
St-9	49	131-34-2.5	Jasper	Approximately 250 ft. downstream from Highway "P" Bridge, Sec. 25, T28N, R34W.

Spring River Basin (cont.)

STATION	MAP NO.	STREAM MILE	COUNTY	DESCRIPTION
Ss-3	50	131-27-48	Newton	Approximately 500 ft. downstream from Highway "60" Bridge, Sec. 6, T25N, R29W.
Ss-4	51	131-27-45	Newton	Approximately 50 ft. upstream from Highway "W" Bridge, Sec. 26, T26N, R30W.
Ss-10	52	131-27-12	Newton	Approximately 1,800 ft. upstream from a county road bridge, Sec. 29, T27N, R33W.

TABLE II - 2
SAMPLING STATION CHARACTERISTICS
JAMES, ELK, AND SPRING BASINS
James River Basin

STATION	SITUATION TYPE	BOTTOM	AVERAGE WIDTH	AVERAGE DEPTH	VEGETATION	SURROUNDINGS	REMARKS
J-1	Numerous small pools and riffles.	Rubble 50% Gravel 50%	6.9 ft.	0.2 ft.	Tree lined banks.	Rolling hills. Timber and pasture land. Dairy and beef cattle farming.	Cattle watering.
J-2	Deep large pools and shallow riffles.	Rubble 20% Gravel 80%	22 ft.	0.3 ft.	Tree lined banks; water willow.	Rolling hills. Timber and pasture. Valley broad. Row crop and pasture. Dairy farming.	Cattle watering. Fishing. Swimming.
Jp-1	Small pools and numerous riffles. Springs abundant.	Rubble 40% Gravel 50% Boulders 10%	22 ft.	0.3 ft.	Tree lined banks. Water willow, water cress.	Rolling hills. Timber and pasture land. Dairy farming. Small built up area.	Cattle watering. Fishing.
Js-1	Small pools and riffles. Large spring discharge upstream 2 miles.	Rubble 60% Gravel 40%	10 ft.	0.2 ft.	Tree lined banks.	Highly built-up area. Large lime industry ¼ mile upstream. Ready-mix concrete plant same place.	

SAMPLING STATION CHARACTERISTICS (cont.)

James River Basin

STATION	SITUATION TYPE	BOTTOM	AVERAGE WIDTH	AVERAGE DEPTH	VEGETATION	SURROUNDINGS	REMARKS
J-3	Deep large pools.	Rubble 20% Gravel 30% Bed Rock 50%	47 ft.	0.6 ft.	Tree lined banks; water willow.	Small reservoir upstream. Rolling hills, timber and pasture land. Built-up area. Beef and dairy cattle farming.	Fishing. Irrigation of truck farm. Cattle watering.
J-4	Long stretch of uniform depth with few riffles.	Rubble 50% Gravel 20% Shingle 20% Boulders 10% Stable	27 ft.	0.6 ft.	Tree lined banks; water willow.	Rolling hills, timber, pasture dairy farm. Built-up area upstream.	Fishing. Floating, boating cattle watering, pasture irrigation.
Jwsp-1	A large spring discharge.	Rubble 10% Gravel 90% Stable	23 ft.	0.7 ft.	Shaded by trees.	Rolling hills, pasture & timber. Dairy farming. Built-up area upstream.	Appeared to be receiving wastewater discharge from large municipal waste treatment plant upstream.
Jw-1	Small pools and riffles.	Rubble 30% Gravel 70% Stable	12 ft.	0.2 ft.	Tree & grass lined banks.	Rolling hills. dairy farming, pasture. Built-up area.	Large municipal wastewater treatment plant ½ mile upstream. A large municipality 6 miles upstream. Cattle watering.

SAMPLING STATION CHARACTERISTICS (cont.)

James River Basin

STATION	SITUATION TYPE	BOTTOM	AVERAGE WIDTH	AVERAGE DEPTH	VEGETATION	SURROUNDINGS	REMARKS
Jw-2	Small pools and riffles.	Rubble 40% Gravel 60% Stable	7 ft.	1.6 ft.	Tree lined banks.	Rolling hills, timber & pasture. Dairy farming. Valley broad and open. Some row crops.	Cattle watering.
J-5	Long sections of stream with uniform depth and shallow swift riffles.	Rubble 25% Gravel 5% Boulders 5% Bed Rock 65%	49 ft.	0.8 ft.	Tree lined banks.	Steeply rolling hills with timber and pasture. Valley narrow. Dairy farming.	Fishing, float boating, cattle watering. Cabins along the stream.
J-6	Long deep, straight stretch with shallow, swift riffles.	Rubble 70% Gravel 30%	48 ft.	0.7 ft.	Tree lined banks.	Steep, rolling hills with timber and pasture. Pasture with dairy farming. Resort area.	Fishing, Swimming, Boating, Canoeing, Cattle watering.
Jc-1	Short, deep pools and numerous riffles.	Rubble 50% Gravel 50%	44 ft.	0.9 ft.	Tree lined banks. Water willow in stream.	Rolling hills. Timber and pasture land. Valley broad and open. Pasture, dairy cattle.	Fishing, cattle watering.
J-7	Long straight stretches; few riffles.	Rubble 50% Gravel 50%	83 ft.	0.7 ft.	Tree lined banks. Water willow in the stream.	Steeply rolling, rocky hills. Timber. Valley narrow. Dairy cattle,pasture	Fishing, boating, canoeing.

SAMPLING STATION CHARACTERISTICS (cont.)

James River Basin

STATION	SITUATION TYPE	BOTTOM	AVERAGE WIDTH	AVERAGE DEPTH	VEGETATION	SURROUNDINGS	REMARKS
J-8	Long, deep, straight stretches. Few riffles.	Rubble and Shingle 90% Boulders 2% Gravel 8%	56 ft.	0.9 ft.	Tree lined banks.	Very steeply rolling hills. Rocks and timber. Valley narrow. Dairy cattle, pasture. Small community 2 miles upstream.	Fishing, swimming, boating, canoeing, cattle watering. Highly used for recreation.
Jf-1	Long pools and riffles.	Rubble 60% Gravel 38% Boulders 2%	34 ft.	0.5 ft.	Grass and tree lined banks.	Rolling hills, timber & pasture dairy & beef cattle farming, valley broad, open, some row crops.	Fishing, cattle watering, swimming.
Jf-2	Long pools and riffles. Small impoundment 300 ft. upstream.	Rubble 30% Gravel 20% Bed Rock 50%	21 ft.	0.5 ft.	Tree lined banks.	Rolling hills, timber & pasture land. Cattle farming. Built-up area. Cabins along small impoundment upstream.	Fishing, float boating & canoeing, swimming, cattle watering.
Jf-3	Long deep pools and riffles. Small impoundment ½ mile upstream.	Rubble 50% Gravel 50%	17.5 ft.	0.5 ft.	Tree lined banks.	Rolling hills, timber & pasture; open valley. Small town ½ mile upstream with waste-	Fishing, cattle watering, swimming, boating and canoeing.

SAMPLING STATION CHARACTERISTICS (cont.)

James River Basin

STATION	SITUATION TYPE	BOTTOM	AVERAGE WIDTH	AVERAGE DEPTH	VEGETATION	SURROUNDINGS	REMARKS
Jf-3 (cont.)						water plant; small cheese plant same place with no treatment.	
Jf-4	Long deep straight stretches and long shallow stretches with swift current.	Rubble 50% Gravel 50%	59 ft.	0.9 ft.	Tree lined banks.	Rolling hills with timber & pasture. Broad open valley. Dairy farming.	Fishing, cattle watering, swimming, boating and canoeing.
Jfl-1	Shallow pools and numerous riffles.	Boulder 1% Rubble 60% Gravel 39%	11 ft.	0.4 ft.	Tree lined banks.	Rolling hills, timber and pasture, broad open valley, mostly pasture. Small city with waste stabilization lagoon about 1 mile upstream.	Fishing, cattle watering, canoeing.
Jfl-2	Deep pools and numerous riffles.	Boulders 2% Rubble 60% Gravel 38%	18 ft.	1.0 ft.	Tree lined banks. Water willow in the stream.	Very steeply rolling hills, mostly timber. Valley narrow with some pasture.	Fishing, boating, canoeing, swimming, cattle watering.

SAMPLING STATION CHARACTERISTICS (cont.)

Elk River Basin

STATION	SITUATION TYPE	BOTTOM	AVERAGE WIDTH	AVERAGE DEPTH	VEGETATION	SURROUNDINGS	REMARKS
Ebs-1	Numerous small pools & riffles.	Rubble 50% Gravel 50%	27 ft.	1.0 ft.	Tree lined banks; water willows.	Rough steeply rolling hills; timber covered. Valleys narrow. Pasture land.	Swimming, fishing, cattle watering.
Els-1	Numerous small pools & riffles.	Shingle 45% Rubble 25% Gravel 30%	26 ft.	0.5 ft.	Tree lined banks; water willows.	Rough steeply rolling hills. Timber covered. Valleys narrow. Pasture land.	Fishing, cattle watering.
E-1	Large deep pools and riffles.	Rubble 20% Gravel 80%	52 ft.	1.0 ft.	Tree lined banks; water willows.	Rolling hills, timber - pasture. Broad valley. City of Pineville.	Swimming, fishing, cattle watering, canoeing.
Ei-1	Small pools and riffles.	Rubble 15% Gravel 85%	43 ft.	1.0 ft.	Tree lined banks.	Steeply rolling hills. Timber. Broad open valley. Pasture land.	Fishing, cattle watering, gravel removal.
Ei-2	Longer deep pools and riffles.	Rubble 40% Gravel 60%	83 ft.	0.8 ft.	Tree lined banks; water willows.	Steeply rolling hills. Timber. Broad valley. Pasture.	Fishing, swimming, boating. Resort area. Cattle watering.

SAMPLING STATION CHARACTERISTICS (cont.)

Elk River Basin

STATION	SITUATION TYPE	BOTTOM	AVERAGE WIDTH	AVERAGE DEPTH	VEGETATION	SURROUNDINGS	REMARKS
E-2	Long deep pools and riffles	Rubble 10% Shingle 50% Gravel 40%	81 ft.	1.3 ft.	Tree lined banks; water willows.	Steeply rolling hills. Timber. Broad open valley. Pasture.	Swimming, fishing, cattle watering, boating and canoeing. Resort area.
E-3	Long shallow pools with deep spots. Large riffles	Bed Rock 30% Rubble 30% Gravel 40%	100 ft.	2 ft.	Tree lined banks, willow bars, water willows.	Rough steeply rolling hills. Timber. Narrow valley. Pasture.	Swimming, fishing, cattle watering, boating and canoeing. Camping area.
B-1	Numerous shallow pools and riffles.	Rubble 30% Gravel 70%	30 ft.	0.6 ft.	Tree lined banks. Water cress.	Rough steeply rolling hills. Timber. Narrow valley. Pasture.	Fishing, cattle watering, gravel removal.

SAMPLING STATION CHARACTERISTICS (cont.)

Spring River Basin

STATION	SITUATION TYPE	BOTTOM	AVERAGE WIDTH	AVERAGE DEPTH	VEGETATION	SURROUNDINGS	REMARKS
S-1	Long narrow pools & shallow riffles.	Rubble 10% Gravel 85% Silt 5% Unstable	13 ft.	0.5 ft.	Tree lined banks.	Rolling hills, pasture & timber land.	Trout farm & fishery about ½ mile upstream. A large spring enters at this point also. Limited fishing.
S-2	Long narrow pools & shallow riffles.	Rubble 15% Gravel 85% Stable	11.5 ft.	0.3 ft.	Tree lined banks.	Rolling hills, pasture & timber land.	Small town and chemical industry ½ mile upstream.
S-3	Long deep pools & shallow riffles.	Rubble 70% Gravel 30% Stable	13 ft.	0.8 ft.	Tree lined banks.	Rolling hills, pasture & timber. Broad open valley.	Stock watering, fishing.
Sw-1	Small deep pools & numerous shallow riffles.	Rubble 50% Gravel 50% Stable	10 ft.	0.4 ft.	Tree lined banks.	Rolling hills, timber & pasture land.	A small municipal waste treatment plant & a milk industry waste trt. plant approx. 1 mile upstream.
Sh-1	Long shallow pools & shallow riffles.	Rubble 5% Gravel 95% Unstable	11 ft.	0.3 ft.	Grass & some trees along banks.	Rolling hills, pasture & some timber.	Small municipal waste trt. plant approx. 14 miles upstream.

SAMPLING STATION CHARACTERISTICS (cont.)

Spring River Basin

STATION	SITUATION TYPE	BOTTOM	AVERAGE WIDTH	AVERAGE DEPTH	VEGETATION	SURROUNDINGS	REMARKS
S-4	Long deep pools & swift & shallow riffles.	Rubble 15% Gravel 85%	47 ft.	0.6 ft.	Tree lined banks.	Rolling hills, pasture with some timber. Broad open valley.	Some cattle water & small amount of irrigation of pasture upstream. Fishing.
S-5	Large deep pools & deep riffles.	Rubble 60% Gravel 30% Boulders 10% Stable	69 ft.	1.2 ft.	Tree lined banks, water willow & willow bars.	Rolling hills, pasture & timber. High mud banks.	Fishing, cattle watering. Some irrigation of pasture land.
S-6	Large deep pools & broad shallow riffles.	Rubble 25% Gravel 65% White sediment Unstable	120 ft.	0.9 ft.	Tree lined banks, water willow.	Gently rolling hills with pasture & some timbers. High mud banks. Broad open valley with some row crops.	Fishing. Municipal waste treatment plant approx. 2 miles upstream & 2 lime stone cutting industries discharging their waste.
Snf-1	Small deep pools & shallow riffles. No flow during summer or fall.	Gravel 100% Unstable	Dry during summer & fall seasons except for treated sewage flow.		Tree lined banks	Gently rolling land with timber & pasture. Broad open valley. Some row crops.	Small municipal waste treatment plant upstream approx. 1 mile.

SAMPLING STATION CHARACTERISTICS (cont.)

Spring River Basin

STATION	SITUATION TYPE	BOTTOM	AVERAGE WIDTH	AVERAGE DEPTH	VEGETATION	SURROUNDINGS	REMARKS
Snf-2	Long deep pools & shallow riffles.	Rubble 60% Gravel 30% Boulders 10% Stable	Little flow in summer and fall.		Grass, forbs & few trees.	Prairie land. Pasture & row crops.	Small municipal waste treatment lagoon upstream approx. 4 miles Fishing.
Snf-3	Large long, very deep pools & a few shallow riffles.	Solid Rock 60% Sand 10% Silt 10% Boulders 20% Stable	19 ft.	0.5 ft.	Tree lined, high mud banks.	Prairie land, hay & row crops. Some old coal mines upstream.	Fishing camps along the stream.
S-7	Large long deep pools, and swift riffles.	Rubble 10% Gravel 90%	76 ft.	0.8 ft.	Tree lined high mud banks.	Pasture, hay & row crops.	Fishing & cattle watering. Boating & canoeing.
S-8	Large long deep pools & swift riffles.	Rubble 50% Gravel 50% Stable	95 ft.	1.0 ft.	Tree lined high mud banks.	Rolling land, timber, row crops & pasture.	Fishing & cattle watering. Boating & canoeing.
Sc-1	Deep pools & numerous riffles; swift.	Rubble 40% Gravel 20% Boulders 10% Bed Rock 30% Stable	8.5 ft.	1.2 ft.	Tree & grass lined banks; water willow.	Rolling hills, timber, pasture & row crops. Dairy farming.	Fishing & cattle watering.

SAMPLING STATION CHARACTERISTICS (cont.)

Spring River Basin

STATION	SITUATION TYPE	BOTTOM	AVERAGE WIDTH	AVERAGE DEPTH	VEGETATION	SURROUNDINGS	REMARKS
Sc-2	Shallow long pools & riffles.	Rubble 50% Gravel 49% Boulders 1% Stable	43 ft.	0.4 ft.	Tree & weed lined banks.	Rolling hills, timber, pasture, dairy & beef cattle farming, row crops.	Small municipal lagoon about 4 miles upstream. Fishing.
Sc-3	Long deep pools & riffles.	Rubble 50% Gravel 50% Stable	36 ft.	0.9 ft.	Tree & forb lined banks.	Rolling hills, timber & pasture. Dairy & beef cattle farming.	Fishing & cattle watering.
Sc-4	Long deep pools & riffles.	Rubble 40% Gravel 60% Unstable	45 ft.	1.0 ft.	Tree & forb lined banks.	Rolling hills, timber & pasture. Broad open valley.	Large chemical industrial complex approx. 1 mile upstream.
Sc-5	Long deep pools and riffles.	Rubble 29% Gravel 70% Boulders 1% Stable	31 ft.	0.7 ft.	Tree lined banks. Willows in the riffle.	Flat to rolling land. Old zinc & lead mining area. Numerous shallow underground mines & limestone tailing piles.	
Sc-6	Long pools & riffles.	Rubble 30% Gravel 70% Stable	19 ft.	1.1 ft.	Tree lined banks.	Gently rolling land Built-up area. Industrial area. Old lead & zinc mining area.	The old ore body crossed under the stream near this station. Municipal waste trt. facility 1 mile upstream.

SAMPLING STATION CHARACTERISTICS (cont.)

Spring River Basin

STATION	SITUATION TYPE	BOTTOM	AVERAGE WIDTH	AVERAGE DEPTH	VEGETATION	SURROUNDINGS	REMARKS
Sc-7	Long deep pools & few riffles; swift.	Rubble 50% Gravel 50% Stable	70 ft.	1.2 ft.	Tree & forb lined banks.	Gently rolling land. Pasture land. Built-up area. Old zinc & lead mining area. Some coal mines in the area.	Municipal waste treatment discharge approx. 2 miles upstream. Fishing.
Sc-8	Long pools & shallow riffles; swift.	Rubble 50% Gravel 50% Stable	57 ft.	0.8 ft.	Tree lined banks.	Flat land. Broad open valley. Row crops, pasture, hay & very little timber.	Largely a farming area. Fishing.
St-9	Long deep pools & shallow swift riffles.	Rubble 40% Gravel 60% Stable	30 ft.	0.8 ft.	Tree lined banks.	Rolling hills, narrow valley. Built-up area. Industrial area. Old lead & zinc mining area.	Flow is largely from a large municipal waste treatment plant approx. 3 miles upstream.
Ss-3	Long deep pools & shallow swift riffles.	Rubble 50% Gravel 50% Stable	39 ft.	0.6 ft.	Tree lined banks.	Gently rolling hills with timber & pasture.	Fishing & stock watering.
Ss-4	Long deep pools & riffles.	Rubble 40% Gravel 59% Boulders 1% Stable	76 ft.	1.3 ft.	Tree lined banks.	Rolling hills, pasture & timber land. Broad open valley. Beef & cattle farming	Stock watering, fishing.

SAMPLING STATION CHARACTERISTICS (cont.)

Spring River Basin

STATION	SITUATION TYPE	BOTTOM	AVERAGE WIDTH	AVERAGE DEPTH	VEGETATION	SURROUNDINGS	REMARKS
Ss-10	Long very deep pools & riffles.	Rubble 40% Gravel 60% Stable	36 ft.	1.4 ft.	Tree lined banks.	Steep rolling hills. Built-up area. Narrow valley.	Municipal waste treatment facility approx. 3 miles upstream. Fishing. Water supply.

III. GENERAL

III. GENERAL

LOCATION

The area in the Missouri segment of the Elk and Spring River Basins plus the James River Basin is located in the southwestern corner of the State. The Spring and Elk Rivers are interstate; flowing in a westerly direction and joining the Grand (Neosho) River in Oklahoma. The James River is entirely in Missouri and empties into Table Rock Lake of the White River Basin.

The James River heads in Webster County and flows in a southwesterly direction emptying into Table Rock Lake in Stone County, Missouri. Principal tributaries are Flat Creek to the west and Finley Creek to the east.

The Elk River mainstem rises in Barry County and flows west to the Oklahoma state line. A tributary joining the Elk in Missouri is Indian Creek which enters near Lanagan, Missouri. Buffalo Creek crosses the Missouri - Oklahoma line and empties into the Elk River slightly above Grand Lake in Oklahoma. Lost Creek, heading in Newton County, crosses the state line to empty directly into Grand Lake in Oklahoma.

The mainstem of the Spring River heads in the vicinity of Aurora, Missouri, and flows generally northwest. Major tributaries are Center Creek and Shoal Creek which join the Spring River in Kansas, and the North Fork of the Spring River which joins the mainstem in western Jasper County, Missouri.

The portion of the Elk River Basin which was included in the Stream Survey is located in the extreme southwestern corner of Missouri. It is bounded on the north by the Spring River Basin, on the east by the James and White River Basins, and on the west and south by the States of Oklahoma and Arkansas, respectively.

In Missouri the James River Basin encompasses all or part of Douglas, Webster, Greene, Christian, Stone, Lawrence, and Barry Counties; the Elk River Basin, all or part of McDonald, Newton, and Barry Counties; and the Spring River Basin, all or part of Lawrence, Barton, Barry, Newton, Jasper, and Dade Counties. Table III-1 shows the various counties included in the three river basins with the percentage of each county occupied by the individual basins.

TABLE III - 1
COUNTIES OCCUPIED BY
THE JAMES, ELK, AND SPRING RIVER BASINS

	% of County within Basin		
COUNTY	JAMES	ELK	SPRING
Barton			55%
Dade			11%
Jasper			100%
Newton		28%	
McDonald		97%	
Lawrence	3%		72%
Barry	43%	11%	20%
Greene	30%		
Webster	44%		
Douglas	2%		
Christian	51%		1%
Stone	63%		

GEOGRAPHY

Topography of the James River Basin includes gently rolling plains in the headwater sections to rough and hilly country towards its mouth. Most of the soil in the basin is classified as stony loam. Total land area in the James River Basin is 1,460 square miles. All of the James River Basin is in Missouri.

The terrain of the Elk River and its tributaries is mostly very rough and hilly. The valleys of the Elk River Basin are generally very narrow except near the state line. Most of the soil is very rocky and is classed as an Ozark soil.

The eastern section of the Spring River Basin is characterized by terrain which is steep and rugged. The western portion of the basin is mostly low rolling hill country. Soil of the northern portion of the area is associated with prairie type soils, while the soil cover in the southern and central portions is representative of the western Ozark border soils which are moderately productive agriculturally. Generally the best soils are found in the stream valleys and the poorest along the slopes.

Over 80% of the area in the Spring River Basin is inside Missouri. The total area in Missouri is 2089 square miles or 1,336,900 acres.

GEOLOGY

A large portion of the tri-basin area is located in the Springfield Plateau. It rises slightly above the Salem Plateau, which covers most of the Ozarks, and descends gradually to the northwest. The northern portion of the Spring River Basin is included in the Osage Plains, plains of low relief formed in sedimentary rocks of the Pennsylvanian age. The entire area lies south of the line of glaciation. Rock strata vary in age from the older early Mississippian to the younger early Pennsylvanian. Over much of the area,the underlying Mississippian limestone and chert are exposed. Outcroppings of the Pennsylvanian shale are continuous in the northwestern part of the Spring River Basin toward the Osage Plains. Pennsylvanian deposits are found as outliers and sink hole deposits over much of the remainder of the area.

CLIMATE

Moderate winters with long warm summers are the general rule for the James, Elk, and Spring tri-basin area. The temperature seldom falls below $0^{o}F$ in the winter and is rarely above $100^{o}F$ in the summer. The mean temperature for the area is $57^{o}F$. Maximum and minimum recorded temperatures for the area are $118^{o}F$ and $-31^{o}F$ respectively. Annual precipitation in the region is 41-42 inches. Snowfall runoff contributes a minor part to the total annual runoff. Prevailing wind is from a southerly direction with the greatest movement in the spring months. The average growing season is just under 200 days annually.

UTILIZATION OF NATURAL RESOURCES

Agriculture

Agriculture is somewhat more important in the Spring River Basin than in the Elk or James River Basins. Approximately 25% of the land area in the Spring River Basin is used for growing field crops while only 5-10% of the land area is

cultivated in the Elk and James River Basins. Pastureland shows similar patterns among the basins. The principal crops grown in the area are wheat, corn, and soybeans. Accumulatively, these three basins represent a relatively small part of Missouri's total crop production.

Poultry is the most important livestock in the region. The three major basins and two sub-basins (Center and Shoal Creeks) rank 1-5 in poultry units per square mile in Missouri, ranging from 560 units in the Spring River Basin to 2300 units in the Elk River Basin. The total quantity of poultry units in the three basins is estimated at 5 million.

Cattle are moderately important agriculturally also. Concentrations in head per square mile throughout the area range from 75-95 with the total number of cattle at approximately 400,000 head.

Swine production is of minor importance in the area and ranks near the bottom in concentration in Missouri. The total number is about 100,000 head.

Mineral Resources

The principal minerals in the southwestern portion of Missouri are marble, limestone, dolomite, sand and gravel, coal, lead, zinc, asphaltic sandstone, and petroleum. Marble is quarried and processed in the Carthage area of the tri-basin area by Carthage Marble Company and Lacarni Marble Company. Missouri ranks third in tonnage of crushed marble and fifth in value of dimension marble produced in the United States.

All counties in the tri-basin area have quarries and extensive stone resources. Practically all the stone is taken from the Mississippian system in this region. Lime is produced extensively in this region, also. Greene County ranks first in the production of lime in Missouri.

Coal is being mined in only one location in the Missouri portion of the basins, and this is near Asbury, Missouri. Abandoned mines from past operations are found at several locations in the area. Substantial reserves are reportedly present in Barton and Jasper Counties.

Lead and zinc mining was once a very active industry in the Joplin, Missouri, area. Production began to decline about 1920 and is now a minor activity in this area. Low grade lead and zinc reserves are reported to be substantial, however. Emphasis on these ores has been diminished by the recent discovery of the richer ores of the Viburnum, Missouri area. Some sand and gravel is mined in Jasper County, Missouri, and a small amount of petroleum is recovered in Barton County, Missouri.

UTILIZATION OF WATER RESOURCES

Water Supplies

Practically all the municipal water supplies in the James, Elk, and Spring River Basins are derived form potable groundwater supplies. All but a few cities in the three basins depend upon one or more drilled wells as a water source.

Barton and Jasper County public water supply districts supply water to a number of small communities in the Spring River Basin. Other public water supply districts in the three basin area include Newton and Greene County public water supply districts.

Springfield depends upon a combination of reservoirs, deep wells, and a spring. Three reservoirs and three deep wells supply the majority of the water used by the City.

Two cities in the area use a stream for their municipal water needs. Joplin and Neosho both draw their supplies from Shoal Creek, a major tributary to the Spring River.

Most of the groundwater supplies in the basins have favorable chemical and physical properties. Total hardness is moderate and salinity of the water is relatively low. Total dissolved solids are generally 300 ppm or less.

Waste Disposal

Waste disposal in this portion of Missouri represents a sizable problem, more so

than many other areas of similar size within the state. This is due to several factors.

Several large municipalities and industries discharge waste in headwater areas with practically no benefit of dilution. The streams of this area are highly valued aesthetically and receive much recreational use. Any waste discharges to streams of this nature must consequently be of high quality to maintain these values and uses. The entry of waste discharges into underground aquifers has been found to be another major problem in this area.

Several streams in the basins which receive waste discharges have been found to be losing, at times causing water quality problems with nearby springs and groundwater supplies.

Most of the smaller cities in the area which have sewerage facilities are served by oxidation lagoons. This type of treatment is the most economical for a small community and has shown to provide a suitable degree of treatment when properly operated and maintained.

The mid-size and larger municipalities in the tri-basin area provide mechanical treatment, generally in the form of trickling filter plants. The largest city in the area, Springfield, employs the use of activated sludge plants. In several mechanical plant installations, a polishing lagoon is used before final discharge. All of the mechanical plants in the Spring, Elk, and James River Basins are designed to provide at least secondary treatment under normal flow conditions and when operated correctly.

Although treatment facilities serving the larger cities in the basins provide 90-95% reduction of biochemical oxygen demand, a substantial amount of organic and nutrient material remain in the discharge. When this remaining organic and nutrient material enters a clear water, low flow receiving stream, a significant amount of change can occur to the existing natural conditions. The small tributaries which receive wastes from Springfield and Joplin show a substantial amount of organic enrichment by the growth of large amounts of algae and organisms with a high level of organic tolerance. Numerous studies have been made and are continuing to be made to improve these situations.

Industry is a major wastewater contributor in several localities within the area. Practically all industries with significant waste discharges to the James River Basin are located in or near Springfield. Similarly, industry with the most effect on the water quality of the Spring River Basin is in the Joplin-Carthage area. Industry is not centralized in the Elk River Basin but rather is dispersed throughout McDonald County.

Industrial waste discharges to the James River Basin from Springfield are primarily in the form of cooling water. A small amount of process wastes is discharged. Where treatment of these wastes is required it is usually provided in the form of retention basins. All of these discharges enter the watershed ahead of Springfield Southwest Treatment Plant discharge, and their water quality influence is lost below that point under normal streamflow conditions.

The only other major industry discharging wastes to the James River Basin is a cheese plant located along Finley Creek. Serious problems have occurred in Finley Creek in the past from this operation; however, adequate treatment facilities presently serving this plant have greatly lessened the degradation of Finley Creek.

Poultry processing is the major industry in the Elk River Basin. At the present time the facilities to treat these wastes are overloaded and causing nuisance problems in the receiving streams. Irrigation of the wastes or a high degree of treatment are the present proposals being reviewed to alleviate these problems. Industrial waste discharges have a greater influence on the water quality of the Elk River Basin than do municipal waste discharges; however, these problems are largely local in nature.

Center Creek receives most of the industrial waste discharged to the Spring River Basin. Wastes discharged from chemical industries to Center Creek have been and are creating water quality problems in Center Creek. The large quantity of ammonia which is discharged has, in the past, been responsible for toxic conditions in the creek and are thought to be the primary cause for oxygen deficits which are commonly found. The water quality problem in Center Creek is quite complicated. Extensive studies are needed to sufficiently correct this problem.

Industrial waste is a major component of the total waste load entering some municipal facilities. In several cities throughout the tri-basin area, industrial wastes comprise the largest portion of the city's discharge.

A listing of all the municipal and the major industrial waste sources, as they were during the Stream Survey, is tabulated in tables III-5 and III-6.

A substantial amount of change has occurred to the waste discharges between the time of the Stream Survey and the publication of the report. In many cases a municipality has grown thus increasing the quantity of wastes. Addition to or enlargement of treatment facilities has occurred in most of these areas to meet this increased load; in some areas it has not.

New industry has been established in the three basins. Some provided their own waste treatment while others connected to city sewers thus further loading the city's facility.

These changes, among others, undoubtedly have influenced the water quality of the James, Elk, and Spring River Basins to some degree.

The current status of all known waste sources to the James, Elk, and Spring Rivers is tabulated in Tables III-7 and III-8. Comparison of these tables with Tables III-5 and III-6 will illustrate changes which have occurred during this interim period.

TABLE III - 2
PUBLIC WATER SUPPLIES *
JAMES, ELK AND SPRING BASINS

James River Basin

MUNICIPALITY	POPULATION		NO. OF SERVICES	OWNERSHIP	SOURCE OF SUPPLY	MILLION GALLONS PER DAY	
	1970	SERVED				CAPACITY	CONSUMPTION
Battlefield	60				Greene Co. PWSD 01		
Cassville	1451	1500	800	M	3 wells	1.440	.200
Clever	283	280	180	M	2 wells	.036	.020
Crane	954	954	494	M	2 wells	.835	.072
Fordland	302	340	151	M	1 well	.216	.013
Marshfield	2221	2200	1200	M	2 wells	1.728	.240
Nixa	944	994	535	M	2 wells	.720	.110
Ozark	1536	2000	900	M	3 wells	2.160	.400
Purdy	467	475	268	M	2 wells	.432	.040
Reeds Spring	327	350	170	M	2 wells	.274	.050
Republic	1519	3000	851	M	2 wells	1.210	.200
Rogersville	447	447	225	M	1 well	.144	.025
Seymour	1046	1046	590	M	2 wells	.727	.065
Sparta	272	275	190	M	1 well	.144	.015
Springfield	99558	125000	33340	M	3 res.; 3 wells; 1 spring	24.000	10.000
Greene Co. PWSD 01		400	160	M	1 well	.288	.030
Elk River Basin							
Anderson	992	992	550	M	3 wells	.216	.150
Fairview	249	249	80	M	1 well	.212	.010
Goodman	540	540	220	M	1 well	.172	.040
Lanagan	357	357	140	M	1 well	.302	.025
Noel	736	800	400	P	2 wells; intercon. with North Noel	.756	.700
Pineville	454	464	200	M	2 wells	.396	.090
Seligman	387	375	201	M	1 well	.087	.015
Seneca	1478	1385	617	M	2 wells	.936	.310
Southwest City	504	550	240	M	4 wells; 2 systems	.259	.060
Stark City	120				Newton Co. PWSD 01		
Washburn	223	250	108	M	1 well	.144	.013
Newton Co. PWSD 01		243	81	M	1 well	.176	.012

Spring River Basin

MUNICIPALITY	POPULATION		NO. OF SERVICES	OWNERSHIP	SOURCE OF SUPPLY	MILLION GALLONS PER DAY	
	1970	SERVED				CAPACITY	CONSUMPTION
Alba	336	336	152	M	1 well	.216	.030
Asbury	186	220	100	M	1 well	.180	.020
Aurora	4682	4700	2167	P	3 wells; intercon. with Verona	1.872	.800
Belle Center					Jasper Co. PWSD 01		
Billings	602	602	300	M	2 wells	.059	.003
Boston	50				Barton Co. PWSD 01		
Butterfield	125	125	60	M	1 well	.150	.008
Central City					Jasper Co. PWSD 01		
Carl Junction	1220	1554	550	M	3 wells	.430	.120
Carterville	1443	1443	550	M	Webb City	2.100	.100
Carthage	11264	12000	2670	M	6 wells	2.070	1.000
Diamond	453	500	200	M	1 well	.115	.038
Exeter	294	294	181	M	1 well	.173	.040
Golden City	714	714	400	M	2 wells	.316	.060
Granby	1808	1808	600	M	2 wells	.800	.300
Howard					Jasper Co. PWSD 01		
Iantha	135				Barton Co. PWSD 01		
Jasper	746	787	373	M	1 well	.230	.060
Joplin	38958	51600	14742	P	Shoal Creek	12.000	6.500
Kenoma	65				Barton Co. PWSD 01		
Lamar	3608	3750	1508	M	Lamar Lake; aux. well	1.000	.450
Lamar Heights	113				Barton Co. PWSD 01		
Marionville	1251	1500	567	P	2 wells	.325	.141
Miller	601	601	325	M	2 wells	.350	.060
Monett	5359	5359	2537	M	8 wells	4.260	1.000
Mount Vernon	2381	2550	1050	M	3 wells	1.440	.484
Nashville	100				Barton Co. PWSD 01		
Neosho	7452	7600	3500	M	Shoal Creek	5.500	1.200
Newtonia	153				Newton Co. PWSD 01		
Oakton	30				Barton Co. PWSD 01		

Spring River Basin (cont.)

MUNICIPALITY	POPULATION		NO. OF SERVICES	OWNERSHIP	SOURCE OF SUPPLY	MILLION GALLONS PER DAY	
	1970	SERVED				CAPACITY	CONSUMPTION
Oronogo	513	513	175	M	2 wells	.360	.025
Pierce City	1006	1175	510	M	2 wells	.864	.075
Purcell	265	355	160	M	1 well	.144	.024
Sarcoxie	1056	1150	580	M	2 wells	.750	.150
Smithfield	75				Jasper Co. PWSD 01		
Stringtown					Jasper Co. PWSD 01		
Verona	401	600	200	P	1 well; aux. Aurora	1.872	.025
Webb City	6740	3200	2780	M	4 wells	2.100	1.000
Wheaton	341	341	225	M	1 well	.144	.030
Barton Co. PWSD 01		875	656	M	2 wells	.288	
Newton Co. PWSD 01		243	81	M	1 well	.176	.012
Jasper Co. PWSD 01		1500	538	M	Joplin		

* From "Census of Public Water Supplies, 1969"

TABLE III - 3
SPRINGS IN THE JAMES, ELK, AND SPRING RIVER BASINS*

James River Basin

Spring	River Miles Above Mouth	County	Flow Cubic Feet/Sec.
Bell	118-0.5	Webster	.03
Blue	81	Christian	3.33
Brown	50-8-5	Stone	11.0
Camp Cora	88.5	Greene	1.08
Danforth No. 1	96-7	Greene	.37
Danforth No. 2	96-7	Greene	.72
Hunt	88.5-6	Greene	.19
Indian	81	Greene	.2
Jones	96-1.5-1	Greene	1.23
McMurtry	27-51	Barry	.12
Monroe	96-1.5-1.5	Greene	.71
Montague	66-2	Christian	2.81
Mountaindale	128.5	Webster	5.46
Mountain Sinai	70-2	Christian	.44
Ollie Lasley	67-23.5-2.5	Christian	1.8
Pruitt	77-2-1	Greene	.15
Rader	77-5	Greene	16.3
Reeds	41-7	Stone	.32
Round Tree	77-6.5	Greene	.13
Rumfelt	128	Webster	1.67
Sequiota	91-2	Greene	17.1
Sherrod	77-7-3	Greene	.34
Spout	67-6-2	Christian	.28
Stutzman	85.5-0.5	Greene	.10
Tawsemtha	96-4	Greene	.05
Ward	83-2-5	Greene	1.73
Wasson	67-4-3	Christian	.17
Welch	83-2	Greene	.18
Winoka	92	Greene	.23
Youngs	71.5-0.5	Christian	.11

SPRINGS IN THE JAMES, ELK, AND SPRING RIVER BASINS

Spring River Basin

Spring	River Miles Above Mouth	County	Flow Cubic Feet/Sec.
	Spring River		
Big	98-0.5	Lawrence	19.0
McCullom	61	Jasper	1.2
Polk	102-14	Lawrence	1.87
Spout	77-2	Jasper	.02
Spring River	114	Lawrence	5.28
Verona	112	Lawrence	.47
	Shoal Creek		
Bartholic	27-32-5.5-2	Newton	.48
Bartkoski	27-59	Barry	.9
Big	27-32-2	Newton	1.38
Birch	27-33-1	Newton	.26
Boy Scout	27-22.5-1	Newton	1.61
Cave	27-53-3	Barry	3.0
Elm	27-32-5.5-2	Newton	1.20
Hawkins No. 1	27-53-3.5	Barry	1.13
Hawkins No. 2	27-53-3.5	Barry	1.15
Hearell	27-2-0.5	Newton	1.08
Hobo	27-32-1-1	Newton	.65
Kolkmeyer	27-17-0.5	Newton	.1
McCahon	27-32-4	Newton	3.56
Monark	27-32-7	Newton	.1
Morse Park	27-32-2	Newton	.3
Ozark Trout Fm.	27-24-2	Newton	.70
Pierce City	27-48-8	Lawrence	.1
Pioneer	27-58	Barry	.2
Rainbow	27-64.5	Barry	2.74
Sagamount	27-17.5-0.5	Newton	.25
Saginaw	27-18.5-0.5	Newton	.85
Spiva	27-15.5	Newton	.31
Talbert	27-69.5-2	Barry	.4
Unnamed	27-68.5	Barry	.34

SPRINGS IN THE JAMES, ELK, AND SPRING RIVER BASINS

Spring River Basin (cont.)

Spring	River Miles Above Mouth	County	Flow Cubic Feet/Sec.
Unnamed	27-48-2	Newton	.9
Unnamed	27-51	Newton	.1
Unnamed	27-44	Newton	.2
Unnamed	27-64-0.5	Barry	.25
Unnamed	27-21.5-1	Newton	.7
Unnamed	27-20-0.5	Newton	.05
Wallace	27-53-4	Barry	8.4
	Center Creek		
Button	38.5-1.5	Newton	3.5
Clarkson	38-46	Lawrence	10.4
Ell Lynn	38-42-0.5	Newton	.86
Haddock	38-42-0.5-0.5	Newton	6
Mossy	38-22-2-1	Jasper	3
Radar Station	38-8	Jasper	.3
Scotland	38-18.5-3	Jasper	3.08
Sonnywood	38-6-1	Jasper	.55
	Turkey Creek		
Great Western	36.5-5	Jasper	.3

Elk River Basin

Camp Beaver	31-6-1	McDonald	2.18
Fly	31-36-2	Newton	3.2
Kelley	31-6-5	McDonald	.41

* "The Large Springs of Missouri"
Missouri Geological Survey and Water Resources
U.S. Geological Survey

TABLE III - 4
TYPICAL REDUCTION OF WASTES BY TREATMENT PLANTS

Parameter	Raw Sewage	Types of Secondary Treatment Plant Effluents			
		Imhoff, Trickling Filter, Settling	Settling, Trickling Filter, Settling	Settling, Activated Sludge, Settling	Lagoons -265 P.E. per acre
Suspended Solids-ppm	Range 100-500 Avg. 250	20 - 60 30	20 - 40 25	- - - 20	- - - - - -
B.O.D. in ppm	Range 100-500 Avg. 260	15 - 100 35	15 - 80 20	10 - 60 15	10 - 70 - - -
Ammonia NH_3-N, ppm	Range 5 - 35 Avg. 14	1 - 17 1.5	1 - 17 7.5	1 - 17 - - -	0.1 - 7 2.4
Nitrites NO_2-N, ppm	Range 0.00-0.10 Avg. 0.05	0.0 - 1.0 - - -	0.0 - 1.0 0.4	- - - - - -	0.0 - 0.5 0.1
Nitrates NO_3-N, ppm	Range 0.10-0.40 Avg. 0.20	0.5 - 5.23 - - -	0.5 - 10.0 4.5	- - - - - -	0.1 - 5.0 1.5
Phosphate PO_4, ppm	Range 4 - 50 Avg. 30	0.1 - 20 - - -	5 - 20 11	- - - - - -	10 - 30 16.5
Chloride ppm	Range 20 - 80 Avg. 50	20 - 80 50	20 - 80 50	20 - 80 50	20 - 80 50
Conductivity micromhos/cm	Range 400 - 800 Avg. 600	400 - 800 600	400 - 800 600	300 - 700 600	300 - 800 600
Coliform Count/100 ml.	15,000,000 to 30,000,000	1,500,000 to 3,000,000	300,000 to 2,200,000	100,000 to 1,800,000	4,000 to 100,000
Fecal Strep. Count/100 ml.	250,000 to 500,000	25,000 to 500,000	5,000 to 100,000	10,000 to 70,000	1,000 to 5,000

FIGURE III - 1
WASTE DISCHARGE LOCATIONS
JAMES RIVER BASIN

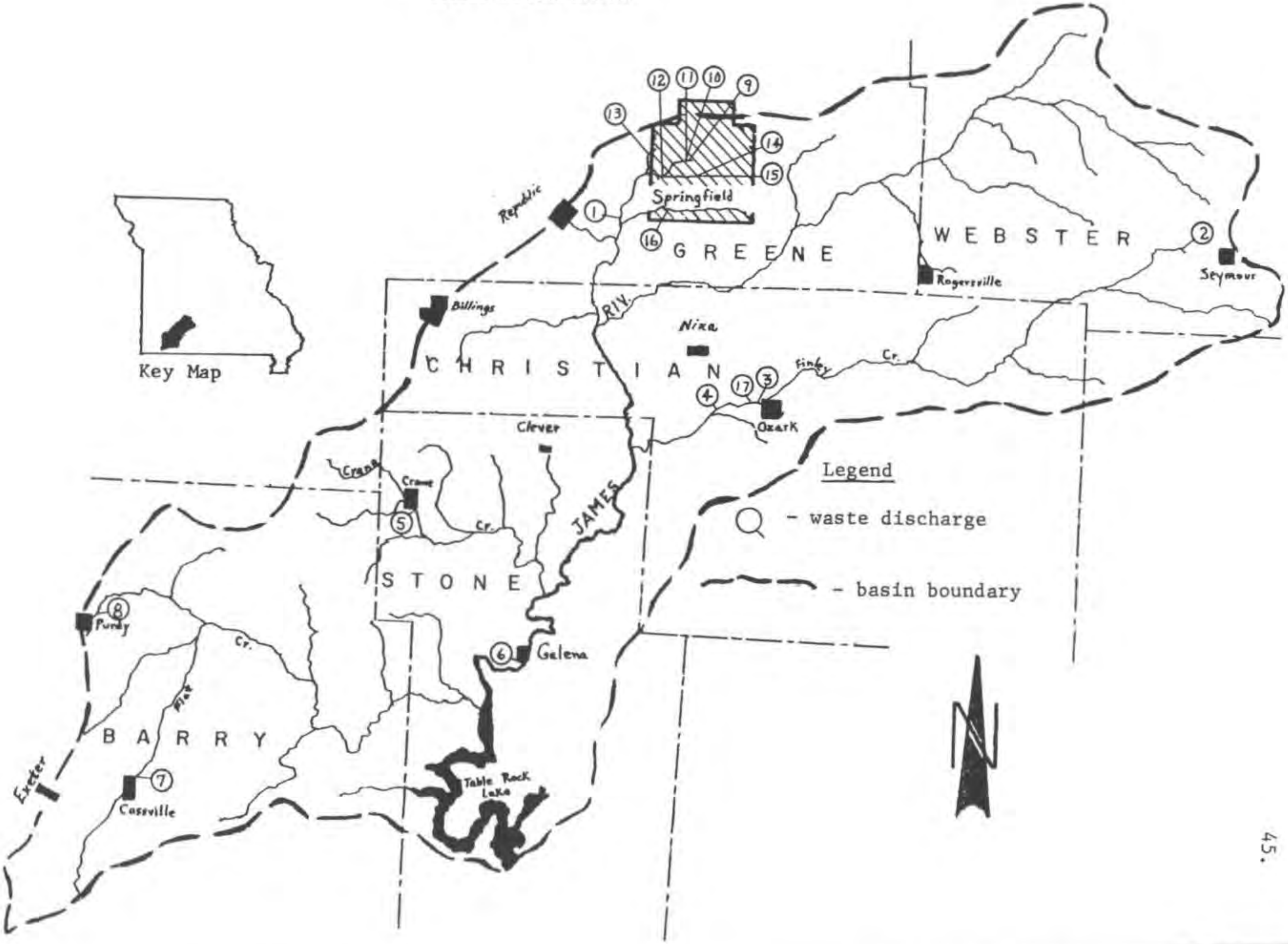

FIGURE III - 2
WASTE DISCHARGE LOCATIONS
ELK AND SPRING RIVER BASINS

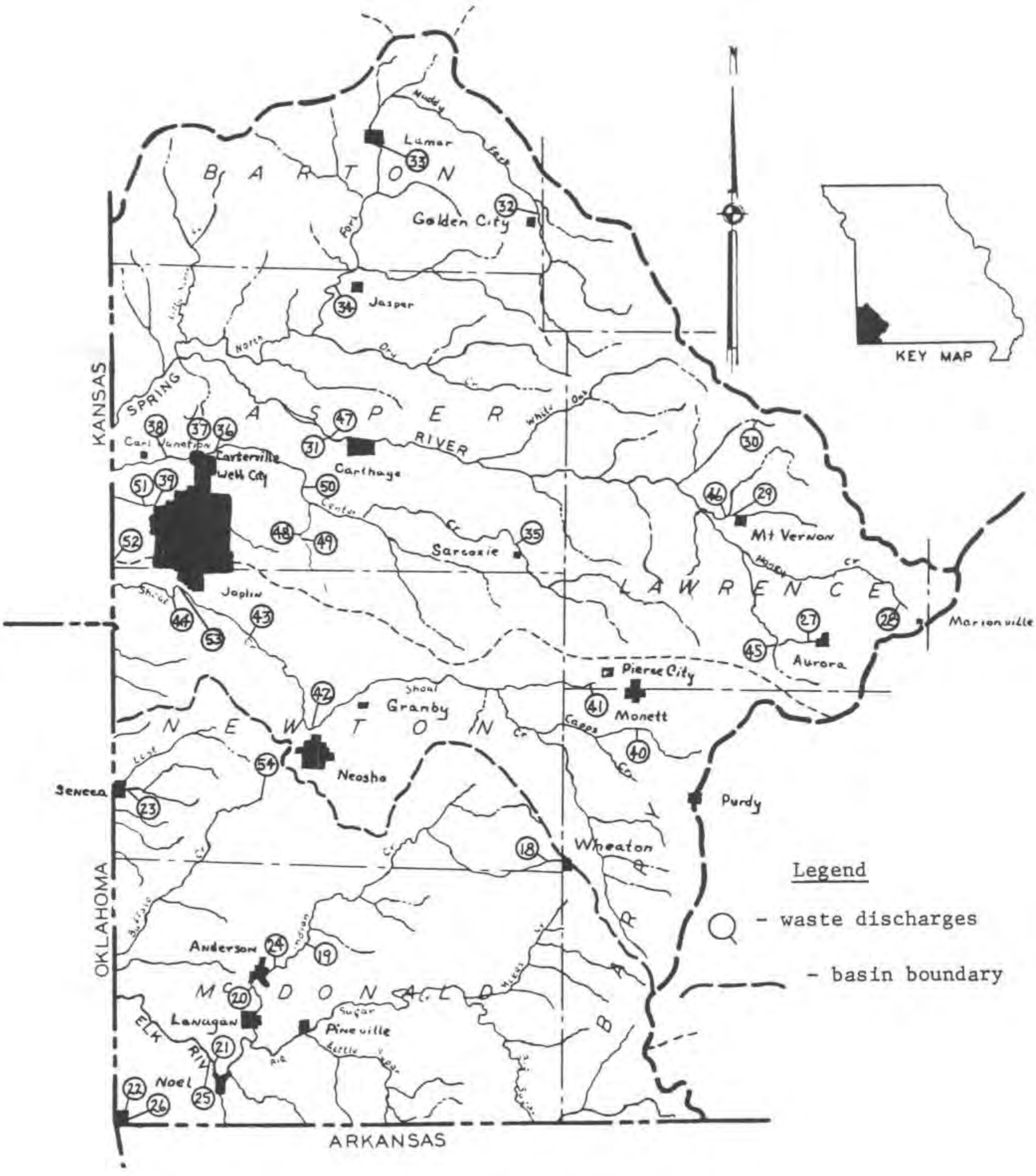

TABLE III - 5

1964 - 1965

MUNICIPAL WASTE SOURCES
JAMES, ELK AND SPRING RIVER BASINS

James River Basin

River, Tributary & Location of Waste Sources	Map No.	River Miles Above Mouth	Design Population Equivalent	Population Equivalent Before Treatment	Nature of Wastes	Treatment Provided	Discharge in c.f.s.	Status of Pollution Abatement
White River								
James River								
Wilson Creek								
Springfield	1	550-77-7	312,246	220,000	Dom. & Ind.	Secondary	17.0	Satisfactory
Finley Creek								
Little Finley Creek								
Seymour	2	550-67-48-3	1,400	1,400	Domestic	Secondary	.217	Need expansion
Ozark	3	550-67-13	1,500	950	Domestic	Secondary	.147	Satisfactory
Nixa	4	550-67-8				Individual systems		
Crane Creek								
Crane	5	550-50-13	1,200	800	Domestic	Secondary	.124	Satisfactory
Galena	6	550-42		100	Domestic	None	.015	Unsatisfactory
Flat Creek								
Cassville	7	550-27-46	3,640	1,300	Domestic	Lagoon system	.202	Satisfactory
Little Flat Creek								
Purdy	8	550-27-33-9	665	350	Domestic	Lagoon system	.054	Satisfactory

Elk River Basin

River, Tributary & Location of Waste Sources	Map No.	River Miles Above Mouth	Design Population Equivalent	Population Equivalent Before Treatment	Nature of Wastes	Treatment Provided	Discharge in c.f.s.	Status of Pollution Abatement
Grand River								
Elk River								
Buffalo Creek								
Camp Crowder	54	114-11-24	45,000	minimal use				Satisfactory

1964 - 1965

MUNICIPAL WASTE SOURCES JAMES, ELK AND SPRING RIVER BASINS

Elk River Basin (cont.)

River, Tributary & Location of Waste Sources	Map No.	River Miles Above Mouth	Design Population Equivalent	Population Equivalent Before Treatment	Nature of Wastes	Treatment Provided	Discharge in c.f.s.	Status of Pollution Abateme
Indian Creek								
North Indian Creek								
South Indian Creek								
Wheaton	18	114-31-26-0.5-11	1,040	300	Domestic	Lagoon system	.047	Satisfactory
Unnamed Creek								
Goodman	19	114-31-5-10		500	Domestic	Individual systems	None	
Anderson	20	114-31-5	4,600	4,100	Dom. & Ind.	Lagoon	.50	Satisfactory
Noel	21	114-25.5		600	Domestic	Individual systems		
Honey Creek								
Southwest City	22	104-14	805	400	Domestic	Lagoon system	.06	Satisfactory
Lost Creek								
Seneca	23	130-10		1,500	Domestic	Individual systems		

Spring River Basin

River, Tributary & Location of Waste Sources	Map No.	River Miles Above Mouth	Design Population Equivalent	Population Equivalent Before Treatment	Nature of Wastes	Treatment Provided	Discharge in c.f.s.	Status of Pollution Abateme
Grand River								
Spring River								
Douger Branch								
Aurora	27	131-111-3	11,860	7,800	Dom.& Ind.	Second. + lagoon	1.20	Satisfactory
Honey Creek								
Marionville	28	131-102-16	1,250	1,200	Dom.& Ind.	Lagoon system	.19	Satisfactory

1964 - 1965

MUNICIPAL WASTE SOURCES
JAMES, ELK AND SPRING RIVER BASINS

Spring River Basin (cont.)

River, Tributary & Location of Waste Sources	Map No.	River Miles Above Mouth	Design Population Equivalent	Population Equivalent Before Treatment	Nature of Wastes	Treatment Provided	Discharge in c.f.s.	Status of Pollution Abatement
Williams Creek								
Mount Vernon	29	131-98-4	4,000	2,400	Domestic	Second.	.37	Satisfactory
Stahl Creek								
Miller	30	131-96-7	928	540	Domestic	Lagoon system	.084	Satisfactory
Carthage	31	131-67	12,000	17,000	Dom.& Ind.	Second.	2.50	Expansion needed
North Fork Spring								
Golden City	32	131-52-55	1,500	700	Domestic	Second.	.11	Satisfactory
Lamar		131-52-34	9,000	3,700	Domestic	Lagoon system	.574	Satisfactory
Oppossum Creek								
Jasper	34	131-52-1	4,770	700	Domestic	Lagoon system	.105	Satisfactory
Center Creek								
Sarcoxie	35	131-38-38	1,820	1,000	Domestic	Lagoon system	.155	Satisfactory
Carterville	36	131-38-11		1,300	Domestic	None	.201	Unsatisfactory
Webb City	37	131-38-8	11,860	7,600	Domestic	Lagoon system	1.18	Satisfactory
Carl Junction	38	131-38-4	3,700	1,500	Domestic	Lagoon system	.232	Satisfactory
Turkey Creek								
Joplin	39	131-365-5	56,700	54,600	Dom.& Ind.	Secondary	10.45	Satisfactory
Shoal Creek								
Clear Creek								
Monett	40	131-27-48-13	14,950	22,800	Dom.& Ind.	Secondary +lagoon	.93	Expansion needed

1964 - 1965

MUNICIPAL WASTE SOURCES
JAMES, ELK AND SPRING RIVER BASINS

Spring River Basin (cont.)

River, Tributary & Location of Waste Sources	Map No.	River Miles Above Mouth	Design Population Equivalent	Population Equivalent Before Treatment	Nature of Wastes	Treatment Provided	Discharge in c.f.s.	Status of Pollution Abatemen
Pierce City	41	131-27-48-8	1,580	700	Domestic	Secondary	.107	Satisfactory
Neosho	42	131-27-32	22,500	20,000	Dom.& Ind.	Secondary	1.5	Satisfactory
Diamond	43	131-27-24		400	Domestic	Individ. systems	None	
Joplin	44	131-27-15	23,500	13,100	Dom.& Ind.	Secondary	2.71	Satisfactory

TABLE III - 6

1964 - 1965

INDUSTRIAL WASTE SOURCES
JAMES, ELK AND SPRING RIVER BASINS

James River Basin

River, Tributiary & Location of Waste Sources	Map No.	River Miles Above Mouth	Waste Characteristics	Treatment Provided	Dis-charge in c.f.s.	Status of Pollution Abatement
White River						
James River						
Wilson Creek						
MFA Plant Foods Division	9	550-77-11	Scrubber water; storm water runoff	Settling basin	.2	Unsatisfactory
Producers Produce Company	10	550-77-11	Cooling water	None		Satisfactory
Producers Produce Co. (Creamery)	11	550-77-11	Cooling water	None		Satisfactory
Hoffman-Taff Company, Inc.	12	550-77-11	Cooling water, storm water runoff	Settling basin	1.02	Unsatisfactory
Frisco Railroad	13	550-77-11	Oil, cooling water, emulsifiers, etc.	Oil skimmer		Unsatisfactory
Kraft Foods	14	550-77-11	Cooling, oil spills	None		Unsatisfactory
Kraft Foods Industrial	15	550-77-11	Cooling water	None		Satisfactory
South Creek						
Dayco Corporation	16	550-77-7-3	Cooling water, solvent spills	Settling basin		Unsatisfactory
Finley Creek						
Major Cheese Company	17	550-67-13	Milk wastes, cooling water, 1900 P.E.	None	.750	Unsatisfactory

Elk River Basin

River, Tributiary & Location of Waste Sources	Map No.	River Miles Above Mouth	Waste Characteristics	Treatment Provided	Dis-charge in c.f.s.	Status of Pollution Abatement
Grand River						
Elk River						
Indian Creek						
Seven Valleys Cheese	24	114-31-5	Milk wastes; 8900 P.E.	None	.046	Unsatisfactory
Ralston-Purina	25	114-25.5	Poultry processing wastes. 7650 P.E.	Lagoons	.96	Unsatisfactory

1964 - 1965

INDUSTRIAL WASTE SOURCES
JAMES, ELK AND SPRING RIVER BASINS

Elk River Basin (cont.)

River, Tributiary & Location of Waste Sources	Map No.	River Miles Above Mouth	Waste Characteristics	Treatment Provided	Dis-charge in c.f.s.	Status of Pollution Abatement
O'Brien Foods	26	114-37	Poultry processing wastes. 1515 P.E.	Septic tanks	.149	Unsatisfactory

Spring River Basin

River, Tributiary & Location of Waste Sources	Map No.	River Miles Above Mouth	Waste Characteristics	Treatment Provided	Dis-charge in c.f.s.	Status of Pollution Abatement
Grand River						
Spring River						
Hoffman-Taff Company, Inc.	45	131-11	Process and cooling	Settling basin	.3	Satisfactory
Williams Creek						
Carnation Milk	46	131-111-3	1) Process wastes 2) Cooling water to Creek	1) Second. 2) None		Unsatisfactory
Carthage Marble	47	131-67	Marble dust	None	.93	Unsatisfactory
Center Creek						
Grove Creek						
W.R. Grace Co.	48	131-38-19-3	Process; cooling	Settling basin	.256	Unsatisfactory
ICI Inc. (Atlas)	49	131-38-19-3	NH_3; NO_3; cooling	Settling basin	2.75	Unsatisfactory
Hercules Powder Co.	50	131-38-17	NO_3; NH_3; acids, cooling water	Settling basin	.248	Satisfactory
Turkey Creek						
Eagle-Picher	51	131-36.5-5	Process; plating waste	Settling basin	1.55	Satisfactory
Short Creek						
Farmers Chemical Co.	52	131-30-4	Process & cooling water	Settling basin	.558	Unsatisfactory

1964 - 1965

INDUSTRIAL WASTE SOURCES
JAMES, ELK AND SPRING RIVER BASINS

Spring River Basin (cont.)

River, Tributiary & Location of Waste Sources	Map No.	River Miles Above Mouth	Waste Characteristics	Treatment Provided	Discharge in c.f.s.	Status of Pollution Abatement
Shoal Creek						
Silver Creek						
Herrod Packing Co.	53	131-27-17-4	Process wastes; P.E. 2700	Lagoon	.48	Unsatisfactory

TABLE III - 7

1972

MUNICIPAL WASTE SOURCES JAMES, ELK AND SPRING RIVER BASINS

James River Basin

River, Tributary & Location of Waste Sources	Map No.	River Miles Above Mouth	Design Population Equivalent	Population Equivalent Before Treatment	Nature of Wastes	Treatment Provided	Discharge in c.f.s.	Status of Pollution Abatement
White River								
James River								
Wilson Creek								
Springfield	1	550-77-7	312,246	320,000	Dom.& Ind.	Second. +lagoon	21.700	Expansion planned
Finley Creek								
Little Finley Creek								
Seymour	2	550-67-48-3	1,400	1,400	Domestic	Secondary	.217	Planning new facil
Ozark	3	550-67-13	1,500	2,000	Dom.& Ind.	Secondary	.223	Overloaded
Nixa	4	550-67-8	4,116	1,500	Domestic	Oxidation ditch	.232	Satisfactory
Crane Creek								
Crane	5	550-50-13	1,200	1,000	Domestic	Secondary	.139	Satisfactory
Galena	6	550-42		100	Domestic	None	.016	Unsatisfactory
Flat Creek								
Cassville	7	550-27-46	3,640	1,700	Domestic	Lagoon system	.564	Satisfactory
Little Flat Creek								
Purdy	8	550-27-33-9	665	385	Domestic	Lagoon system	.0596	Satisfactory

Elk River Basin

River, Tributary & Location of Waste Sources	Map No.	River Miles Above Mouth	Design Population Equivalent	Population Equivalent Before Treatment	Nature of Wastes	Treatment Provided	Discharge in c.f.s.	Status of Pollution Abatement
Grand River								
Elk River								
Buffalo Creek								
Camp Crowder	54	114-11-24	45,000	1,350	Domestic	Secondary	.209	Satisfactory

MUNICIPAL WASTE SOURCES
JAMES, ELK AND SPRING RIVER BASINS

Elk River Basin(cont.)

River, Tributary & Location of Waste Sources	Map No.	River Miles Above Mouth	Design Population Equivalent	Population Equivalent Before Treatment	Nature of Wastes	Treatment Provided	Discharge in c.f.s.	Status of Pollution Abatement
Indian Creek								
North Indian Creek								
South Indian Creek								
Wheaton	18	114-31-26-0.5-11	1,040	300	Domestic	Lagoon system	.047	Satisfactory
Unnamed Creek								
Goodman	19	114-31-5-10	902	600	Domestic	Lagoon system	.093	Satisfactory
Anderson	20	114-31-5	4,600	4,200	Dom.& Ind.	Lagoon system	.512	Occasional overload from industry
Noel	21	114-25.5	1,765	650	Domestic	Lagoon system	.101	Satisfactory
Honey Creek								
Southwest City	22	104-14	805	425	Domestic	Lagoon system	.066	Satisfactory
Lost Creek								
Seneca *	23	130-10	2,800	1,400	Domestic	Lagoon system	.217	Satisfactory

* Seneca lagoon is not located in Missouri.

Spring River Basin

River, Tributary & Location of Waste Sources	Map No.	River Miles Above Mouth	Design Population Equivalent	Population Equivalent Before Treatment	Nature of Wastes	Treatment Provided	Discharge in c.f.s.	Status of Pollution Abatement
Grand River								
Spring River								
Douger Branch								
Aurora	27	131-111-3	11,860	10,750	Dom.& Ind.	Secondary + Lagoon	1.42	Satisfactory

1972

MUNICIPAL WASTE SOURCES
JAMES, ELK AND SPRING RIVER BASINS

Spring River Basin (cont.)

River, Tributary & Location of Waste Sources	Map No.	River Miles Above Mouth	Design Population Equivalent	Population Equivalent Before Treatment	Nature of Wastes	Treatment Provided	Discharge in c.f.s.	Status of Pollution Abatement
Honey Creek								
Marionville	28	131-102-16	2,410	1,500	Dom.& Ind.	Lagoon system	.240	Satisfactory
Williams Creek								
Mount Vernon	29	131-98-4	4,000	2,800	Domestic	Secondary	.434	
Stahl Creek								
Miller	30	131-96-7	928	650	Domestic	Lagoon system	.101	Satisfactory
Carthage	31	131-67	19,650	17,000	Dom.& Ind.	Second. +Lagoon	2.71	Satisfactory
North Fork Spring River								
Golden City	32	131-52-55	1,500	1,100	Dom.& Ind.	Second.	.121	Satisfactory
Lamar	33	131-52-34	9,000	3,800	Dom.& Ind.	Lagoon system	.589	Satisfactory
Oppossum Creek								
Jasper	34	131-52-1	4,770	750	Domestic	Lagoon system	.116	Satisfactory
Center Creek								
Sarcoxie	35	131-38-38	1,820	1,050	Domestic	Lagoon system	.163	Satisfactory
Carterville	36	131-38-11	1,600	1,600	Domestic	Lagoon system	.248	Satisfactory
Webb City	37	131-38-8	11,860	6,100	Domestic	Lagoon system	.93	Satisfactory
Carl Junction	38	131-38-4	3,700	1,500	Domestic	Lagoon system	.574	Satisfactory
Turkey Creek								
Joplin	39	131-36.5-5	56,700	64,400	Dom.& Ind.	Second.	12.7	New facilities under const.

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MUNICIPAL WASTE SOURCES
JAMES, ELK AND SPRING RIVER BASINS

Spring River Basin (cont.)

River, Tributary & Location of Waste Sources	Map No.	River Miles Above Mouth	Design Population Equivalent	Population Equivalent Before Treatment	Nature of Wastes	Treatment Provided	Discharge in c.f.s.	Status of Pollution Abatement
Shoal Creek								
Clear Creek								
Monett	40	131-27-48-13	14,950	15,280	Dom.& Ind.	Second.+ Lagoon	1.090	Expansion needed
Pierce City	41	131-27-48-8	1,580	800	Domestic	Second.	.124	Satisfactory
Neosho	42	131-27-37	22,500	32,800	Dom.& Ind.	Second.	1.95	Planning expansion
Diamond	43	131-27-24	1,270	425	Domestic	Lagoon system	.066	Satisfactory
Joplin	44	131-27-15	23,500	18,540	Dom.& Ind.	Second.	4.26	Satisfactory

TABLE III - 8

1972

INDUSTRIAL WASTE SOURCES JAMES, ELK AND SPRING RIVER BASINS

James River Basin

River, Tributiary & Location of Waste Sources	Map No.	River Miles Above Mouth	Waste Characteristics	Treatment Provided	Dis-charge in c.f.s.	Status of Pollution Abatement
White River						
James River						
Wilson Creek						
MFA Plant Foods Division	9	550-77-11	Scrubber water	Settling basin	.2	Satisfactory
Producers Produce Company	10	550-77-11	Cooling water blowdown	None	.39	Satisfactory
Producers Produce Co.(Creamery)	11	550-77-11	Cooling water blowdown	None		Satisfactory
Hoffman-Taft Company, Inc.	12	550-77-11	Cooling water; misc. wastes	Settling basin	.15	Satisfactory
Frisco Railroad	13	550-77-11	Oil, cooling water, emulsifiers, etc.	Oil skimmer & settling basin	1.2	Unsatisfactory
Kraft Foods	14	550-77-11	Cooling water blowdown	None	.31	Satisfactory
Kraft Foods Industrial	15	550-77-11	Cooling water blowdown	None	.08	Satisfactory
South Creek						
Dayco Corporation	16	550-77-7-3	Cooling water	Settling basin	2.32	Satisfactory
Finley Creek						
Major Cheese Co.	17	550-67-13	Milk waste, cooling water; 1080 P.E.	Secondary + Lagoon	.836	Satisfactory

Elk River Basin

River, Tributiary & Location of Waste Sources	Map No.	River Miles Above Mouth	Waste Characteristics	Treatment Provided	Dis-charge in c.f.s.	Status of Pollution Abatement
Grand River						
Elk River						
Indian Creek						
Seven Valleys Cheese Co.	24		No longer exists			

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INDUSTRIAL WASTE SOURCES
JAMES, ELK AND SPRING RIVER BASINS

Elk River Basin (cont.)

River, Tributiary & Location of Waste Sources	Map No.	River Miles Above Mouth	Waste Characteristics	Treatment Provided	Dis-charge in c.f.s.	Status of Pollution Abatement
Ralston Purina	25	114-25.5	Poultry process wastes, 33,000 P.E.	Lagoon system	1.47	Unsatisfactory
Honey Creek						
O'Brien Foods	26	104-14	Poultry process wastes	Lagoon system	.64	Unsatisfactory

Spring River Basin

River, Tributiary & Location of Waste Sources	Map No.	River Miles Above Mouth	Waste Characteristics	Treatment Provided	Dis-charge in c.f.s.	Status of Pollution Abatement
Grand River						
Spring River						
Hoffman-Taff Company, Inc.	45	131-11	Process and cooling	Irrigation	None	Satisfactory
Williams Creek						
Carnation Milk Company	46	131-111-3	Process and sanitary; 13,000 P.E.	Secondary	2.32	Unsatisfactory (over-loaded)
Carthage Marble Co.	47	131-67	Marble dust	Settling basin	.93	Satisfactory
Center Creek						
Grove Creek						
W.R. Grace Co.	48	131-38-19-3	NH_3, NO_3, cooling	Settling basin	.255	Unsatisfactory (additions needed)
ICI, Inc. (Atlas)	49	131-38-19-3	NH_3, NO_3, cooling	Settling basin	2.94	Unsatisfactory (additions needed)
Hercules Powder Co.	50	131-38-17	NO_3, NH_3, Acids, cooling water	Settling basin		Satisfactory
Turkey Creek						
Eagle-Picher Co.	51	131-36.5-5	Process; plating wastes	Settling basin	1.55	Unsatisfactory (additional treatment scheduled)

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INDUSTRIAL WASTE SOURCES
JAMES, ELK AND SPRING RIVER BASINS

Spring River Basin (cont.)

River, Tributiary & Location of Waste Sources	Map No.	River Miles Above Mouth	Waste Characteristics	Treatment Provided	Dis-charge in c.f.s.	Status of Pollution Abatement
Short Creek						
Farmers Chemical Co.	52	131-30-4	Cooling water	None	.1	Satisfactory
Shoal Creek						
Silver Creek						
Herrod Packing Co.	53	131-27-17-4	Process wastes; P.E. 2700	Lagoon	.073	Unsatisfactory (Overloaded)

IV. HYDROLOGIC CHARACTERISTICS OF THE JAMES, ELK, AND SPRING RIVER BASINS

IV. HYDROLOGIC CHARACTERISTICS OF THE JAMES, ELK, AND SPRING RIVER BASINS

STREAMFLOW

The runoff from the James, Elk, and Spring River Basins is measured continuously at several points in the basins. The flow characteristics at these continuous record stations are summarized in Table IV-1.

Low Flows

A comparison of the low flow characteristics of the three basins, based on data from partial record and miscellaneous sites as well as the continuous record stations, indicates some differences in the low flow regimen of the streams. Low flows in the middle and lower James River and upper Spring River Basins are generally higher and better sustained than in the other areas. Also, low flows increase rather uniformly in a downstream direction in the James and Elk River Basins, whereas most of the low flow in the Spring River Basin is derived from the spring fed headwaters with little or no increase below LaRussell.

The lowest discharges recorded in the basins occurred during the severe drought years of the early 1950's. During the years 1952-53, rainfall averaged about 14 inches below normal, making this period one of the driest since climatalogical records began in the region in the late 1800's. The cumulative effect of these two severely dry years, followed by below normal rainfall in 1954, resulted in the lowest streamflows of record in 1954. Table IV-2 shows the minimum recorded flows at the long time gaging stations and the approximate frequencies of the events.

Average Flows

Average annual discharges at the long time continuous record stations show that runoff varies from about 9.5 inches at Waco to about 12.5 inches at Galena. Rainfall averages 41 to 42 inches annually in the basins; thus, 25 to 30 percent of the water falling on the basins as precipitation is available as a surface water supply. The remaining 70-75 percent of the rainfall is used up in the evapotranspiration process and infiltration into the earth's surface.

The average monthly flows at the Galena, Waco, and Tiff City stations are presented in Figure IV-1. Note that the average monthly flow patterns in the basins are quite similar. The highest average runoff occurs during April or May, followed by a rather rapid decline to the September minimums, then a gradual pickup in runoff throughout the winter prior to the rapid spring increases.

Flood Flows

Gaging station records at Galena, Waco, and Tiff City indicate that the magnitude of flood runoff per square mile in the basins is comparable during low order floods. However, during the 50-year flood event, runoff from the Elk River Basin is about twice as great as that from the Spring and James River Basins primarily because of basin shape and slope differences.

The maximum discharges recorded in the basins occurred in the early 1940's. Table IV-3 shows the peak flow of record at the long time gaging stations and the approximate frequencies of the events.

Flows During Period of Study

Streamflow conditions during the period of this study must be compared to long time flow patterns in order to evaluate the significance of the water quality data which were collected. Table IV-4 lists the results of measurements made when samples were taken at or near a site where frequency data are available, and the approximate frequency of low flow events. This table is restricted to a few sampling points and does not reflect the total number of samples taken in the basins.

TABLE IV. - 1 STREAMFLOW CHARACTERISTICS AT CONTINUOUS RECORD STATIONS IN THE JAMES, ELK, AND SPRING RIVER BASINS

Station Name	Drainage area (sq mi)	Period of record	Average Discharge		Period, days	Low flow frequency data						Flood frequency data					
						Annual low flow, in cubic feet per second for indicated recurrence interval 1/ in years						Magnitude of flood in cubic feet per second for indicated recurrence interval 1/ in years					
			cubic feet per second	acre-feet per year		2	5	10	20	30	50	1.2	2.3	5	10	25	50
James River near Springfield	246	1955-68	195	141,200	7	7.0	2.3	1.0	0.4	-	-	4,200	11,000	17,000	22,200	28,800	-
					14	7.8	2.6	1.2	0.5	-	-						
					30	10	3.0	1.4	0.6	-	-						
					60	21	5.3	2.2	0.9	-	-						
					90	27	7.8	3.5	1.5	-	-						
James River at Galena	987	1921-68	927	671,100	7	96	64	35	20	15	10	8,800	21,300	32,000	41,000	52,500	61,500
					14	105	70	39	23	17	12						
					30	120	76	42	25	19	14						
					60	130	84	52	33	26	20						
					90	160	96	68	47	38	30						
Spring River at LaRussell	306	1957-68	192	139,000	7	47	28	20	-	-	-	2,600	5,200	8,800	12,400	-	-
					15	48	30	22	-	-	-						
					30	53	32	24	-	-	-						
Spring River near Waco	1,164	1925-68	807	584,200	7	58	28	19	11	7.2	3.8	8,200	20,000	32,000	42,700	59,000	77,000
					15	65	33	21	12	8.2	5.0						
					30	74	35	23	14	9.6	5.4						
					60	94	44	27	16	11	7.0						
					90	120	54	33	21	16	11						
Elk River near Tiff City	872	1940-68	755	546,600	7	86	38	18	8.0	4.7	-	5,000	18,000	36,000	55,000	82,000	104,000
					14	94	45	22	9.6	5.8	-						
					30	100	50	25	12	7.0	-						
					60	120	56	29	15	9.4	-						
					90	150	68	36	18	12	-						

1/ Recurrence interval is the average interval of time within which an event will be exceeded once. For example, a 50-year flood or drought has a 2-percent chance of occurring in any year.

TABLE IV - 2. MINIMUM FLOWS AT LONG TIME GAGING STATIONS

Station	Minimum recorded flow (cubic feet per second)	Date	Recurrence Interval (years)
James River at Galena	10	9-20-54	40 to 50
Spring River near Waco	4.2	8-28-54	40 to 50
Elk River near Tiff City	5.1	9-5-54	25 to 30

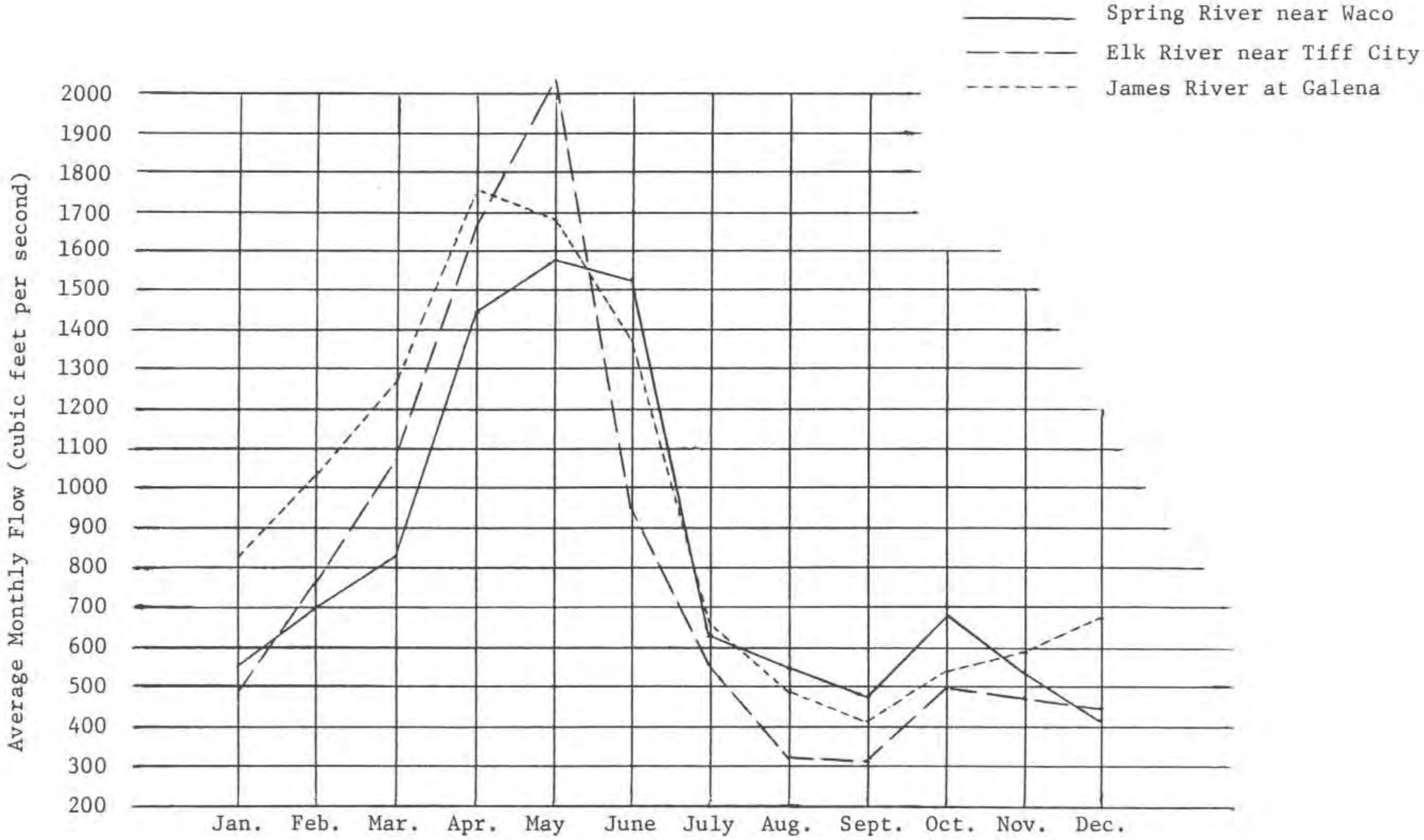

FIGURE IV - 1. AVERAGE MONTHLY FLOWS IN THE JAMES, ELK, AND SPRING RIVER BASINS

TABLE IV - 3. MAXIMUM FLOWS AT LONG TIME GAGING STATIONS

Station	Maximum recorded flow		Date	Recurrence Interval
	(cubic feet per second)	(cubic feet per second per square mile)		(years)
James River at Galena	52,700	54	5-20-43	25
Spring River near Waco	103,000	88	5-19-43	50+
Elk River near Tiff City	137,000	157	4-19-41	50+

TABLE IV - 4 RESULTS OF DISCHARGE MEASUREMENTS AND APPROXIMATE FREQUENCY OF LOW FLOW EVENTS

Stream	Location	Date	Discharge (cubic feet per second)	Recurrence Interval of low flow events (years)
James River	NE¼, Sec. 6, T27N, R22W, at bridge on county road, 2 miles south of Battlefield, Christian County. (J-4)	8-5-64	12.2	2
		10-21-64	8.53	5
		1-19-65	65.9	-
		4-28-65	258	-
Finley Creek	SW¼, Sec. 22, T27N, R21W, at bridge on U.S. Highway 65, one-half mile west of Ozark, Christian County. (Jf-3)	8-20-64	19.3	1
		10-22-64	9.48	5
		1-20-65	33.2	-
		2-1-65	49.0	-
		4-28-65	186	-
		5-3-65	122	-
James River	NE¼, Sec. 14, T24N, R23W, at bridge on county road, 1½ miles southwest of Galena, Stone County. (J-8)	8-6-64	87.3	2
		10-22-64	78.0	2.5
		1-20-65	256	-
Spring River	On line between Secs. 13 and 14, T28N, R28W, at bridge on State Highway 97, 2 miles north of Stotts City, Lawrence County. (S-4)	9-15-64	48.5	1.5
		10-21-64	30.8	3
		11-4-64	30.6	3
		12-16-64	53.7	1
		3-16-65	174	-
		6-1-65	187	-
Spring River	S½, Sec. 3, T29N, R33W, at bridge on county road at Galesburg, Jasper County. (S-7)	9-15-64	66.6	1.5
		12-7-64	85.5	1
		3-17-65	256	-
		6-1-65	306	-

RESULTS OF DISCHARGE MEASUREMENTS AND APPROXIMATE FREQUENCY OF LOW FLOW EVENTS (cont.)

Stream	Location	Date	Discharge (cubic feet per second)	Recurrence Interval of low flow events (years)
Center Creek	On line between Secs. 1 and 2, T27N, R30W, at bridge on State Highway 37, 2 miles northwest of Sarcoxie, Jasper County. (Sc-2)	9-1-64	21.4	1.5
		10-21-64	9.04	5
		11-30-64	21.3	1.5
		2-16-65	23.2	1.5
		6-22-65	62.1	-
Center Creek	NE¼, Sec. 9, T28N, R33W, at bridge on State Highway 171, 2 miles southeast of Carl Junction, Jasper County. (Sc-7)	9-11-64	30.0	2
		10-20-64	20.0	5
		12-1-64	84.9	-
		2-17-65	57.6	-
		6-23-65	137	-
Elk River	SW¼, Sec. 34, T22N, R32W, at bridge on U.S. Highway 71 at south city limits of Pineville, McDonald County. (E-1)	8-19-64	34.9	1.5
		10-20-64	32.6	1.5
		2-2-65	114	-
		5-4-65	277	-
Indian Creek	NE¼, Sec. 18, T22N, R32W, at bridge on State Highway 36, three-fourths mile southeast of Anderson, McDonald County. (Ei-1)	8-18-64	44.2	1.5
		10-20-64	22.5	5
		2-3-65	48.2	1.5
		5-4-65	142	-

GROUNDWATER

Large quantities of potable groundwater are available from groundwater sources in the James, Elk, and Spring River Basins. The only exception is the extreme northwestern corner of the Spring River Basin, in southwestern Barton County and northwestern Jasper County, where the deeper horizons locally yield water which is too high in total dissolved solids to be acceptable. Several shallower zones of Pennsylvanian and Mississippian age also contain mineralized water in this area.

Generally the groundwater is of satisfactory bacteriological quality in the three-basin area except in the Springfield area where the shallower groundwater horizons (Mississippian and Ordovician rocks) are polluted by diverse sources. The pollution has probably entered the groundwater through improperly constructed wells. Many of the shallower horizons, down to and including the Swan Creek sandstone zone in the Cotter Dolomite of Ordovician age, have water with high nitrates, high coliform counts and in some instances gasoline or fuel oil in the water.

Water is available in very small quantities from the Pennsylvanian-age deposits which directly underlie the northwestern part of the basin complex. These deposits are fine grained and for the most part are not to be considered as dependable sources of water.

The Mississippian-age limestones which underlie the three-basin area yield small to moderate amounts of water to wells. The quality of the water in these shallow aquifers could be subject to suspicion in local areas because of the cavernous characteristics exhibited by the limestone. Water recharges rather quickly to the aquifers,and in local areas any source of surface pollution soon finds its way underground. Because of this it is usually wise, where possible, to set well casing through the Mississippian-age rocks.

The most important aquifers in the basins are the Roubidoux Formation, the Gasconade Dolomite, the Gunter member of the Lower Gasconade Dolomite, all of Ordovician age and the Potosi Dolomite of Cambrian age. The Roubidoux has a range in yields of from 5 to 150 gallons a minute with the average being from 15 to 25 gallons a minute. The Gasconade has a range in yields from 15 to 45 gallons a minute with 20 gallons a minute being the average yield. The Gunter has a range in yields of from 25 to 500 gallons a minute. No data

are available concerning yields from the Potosi Formation in the three-basin area with the exception being in the Springfield area where yields in excess of 1000 gallons a minute have been reported for wells penetrating the Potosi.

Water quality in the deeper aquifers is quite good with the exception of the extreme western margin of the three-basin area. In this area, dissolved solids could be higher than is accepted by the Missouri Division of Health for public drinking supplies (500 ppm).

V. THE BENTHOS OF THE STREAMS IN THE JAMES, ELK, AND SPRING RIVER BASINS AS RELATED TO WATER QUALITY

V. THE BENTHOS OF THE STREAMS IN THE JAMES, ELK, AND SPRING RIVER BASINS AS RELATED TO WATER QUALITY

ABSTRACT

Water quality of the James, Elk, and Spring River Basins was evaluated by four seasonal benthic macroinvertebrate collections from 52 riffle stations during 1964-65. Water quality was determined on the basis of: (1) coefficient of similarity; (2) diversity of benthic population; and (3) percentage of clean water organisms. Of the eight stations located in the Elk River Basin, one (Ei-2) was affected by waste discharges. The James River Basin was sampled at twenty stations. Based on benthic macroinvertebrate data, six of the twenty stations were considered polluted (J-5, Js-1, Jw-1, Jw-2, Jf-3). The Spring River Basin was sampled at twenty-four locations. Nine of the twenty-four stations (Sc-4, Sc-5, Sc-6, Sc-7, Sc-8, St-9, Sw-1, S-2, S-6) were considered polluted or seriously affected by waste discharges, five of the nine stations that were considered polluted were located on Center Creek, below an industrial complex.

INTRODUCTION

The water quality of a stream is indicated by the types and relative numbers of various benthic organisms at one particular location. As a result of their inability to move great distances by self motion and their location in the stream bottom, benthic communities are adversely affected by low water quality. When the water quality is low, or polluted, certain species will be eliminated and others may increase to greater numbers than would normally occur.

During the survey of the Elk, James and Spring River Basins, 52 riffle stations were established and sampled seasonally, starting in the summer of 1964 and ending with the spring sampling period in 1965. Eight stations were located in the Elk River Basin, twenty stations in the James River Basin, and twenty-four in the Spring River Basin. In each basin some stations were established to obtain a picture of each stream in as near unpolluted condition as possible, while others were established in order to determine the effects that known sources of pollution had on the benthic life.

The seasonal riffle collections were made to evaluate the water quality of the study streams. The data was collected to be used in the establishment and enforcement of water quality standards to protect the aquatic environment. The study will also provide a testing ground for the evaluation of benthos data in future projects.

METHODS

Six or 12 square feet of riffle bottom were sampled at each station, in accordance with the findings of Kuester (1964). Small streams, under 25 feet in width, were sampled at the 6 square feet rate, and streams of greater width were sampled at the 12 square feet rate.

A heavy nylon bottom net, 20 meshes to the inch, was used to collect the benthic fauna. Organisms were displaced from the riffle bottom by digging up the required number of square feet with a three-pronged cultivator. The organisms were swept by the current into the bottom net positioned about one foot downstream. Large substrate was hand picked to assure removal of organisms which remained attached.

The sample was washed from the bottom net into two screens for sorting. The upper screen was ½-inch hardware cloth and the lower 40 meshes to the inch strainer cloth. Material remaining in the upper screen was checked for organisms and discarded. All material on the lower screen was preserved in 10 percent formaldehyde. The samples were taken to the laboratory for sorting and identification. The material to be sorted was washed free of formaldehyde with water in a 40 mesh strainer cloth sieve. Sugar flotation as described by Anderson (1959) was used to remove most of the organisms. The remaining material was sorted by hand in order to assure removal of heavy organisms, caddis cases and organisms clinging to non-floating material. Organisms were separated into several vials by gross observations of the sorter. The remaining material was returned to the sample jar with the formaldehyde so that the biologist in charge could examine the sorted material.

A dissecting microscope and a compound microscope were used in identification of the organisms. Standard forms were used to record the identification of the organisms, number present, and water displacement in cubic centimeters. Individual organisms were counted except that when large numbers were present, estimates were made by volume measurements and counts of subsamples.

Identification of organisms was as follows:

(1) Flatworms (Platyhelminthes), annelids (Annelida), and round worms (Nematoda) were identified to class.

(2) Flies (Diptera) were identified to family, or genus, depending upon the organism.

(3) Stoneflies (Plecoptera), mayflies (Ephemeroptera), caddisflies (Tricoptera), and mussels (Pelecypoda) were identified to species whenever possible.

(4) Snails (Gastropoda), crustaceans, and insect groups other than those named were identified to species whenever practicable.

Identification was accomplished with the following keys:
Burks, (1953), Frison (1935 & 1942), Johannsen (1934 & 1935), Pennak (1953), Ross (1944), Usinger (1963), Ward & Whipple (1959), and Williams (1954).

Statistical Analysis

Statistical analyses of benthos data should be approached with a high degree of caution. The problems of obtaining quantitative benthos data have been discussed in many papers. Because it is difficult to obtain reliable quantitative data for

benthic populations, Clifford (1966) suggested that the emphasis be placed upon the occurrence of the aquatic invertegrates throughout the stations rather than their densities at particular stations. In this method, the square root of the frequency of occurrence is determined for each taxonomic level. This number is then multiplied by the density of the organisms per unit area, which is called the prominence value.

By using the prominence value, the coefficient of similarity (C) between two stations is calculated as ($C=2W/a+b$), where "a" is the sum of the prominence values of all the taxonomic levels at one station, "b" is the sum of the prominence values at another station and "W" is the sum of the prominence values the two stations have in common for each group. The prominence value selected for "W" is the lowest for the taxonomic level common to both stations. Similarities between stations will be determined in this study by the use of the coefficient of similarity. Unpolluted stations within the same watershed, having similar substrate, would yield a high coefficient of similarity.

Water Quality Criteria

In the discussion of results, the following factors were considered in determining the quality of water at any particular station:

1. Coefficient of similarity to nearby stations should be high. A value of less than 50 will be considered low and one greater than 60 considered high. Low values could result from physical differences (substrate, flow, etc.,), chemical differences, or a combination of both.
2. The diversity of the benthic fauna represented should be great in high quality streams. Stations were expected to harbour 40 or more types of aquatic invertebrate life.
3. Unpolluted stations are expected to have at least 50 per cent of the organisms represented from the clean water groups (i.e. mayfly, stonefly and caddisfly families).
4. The presence of exceptionally large numbers of pollution-tolerant organisms and reduced diversity is indicative of a polluted condition.

Physiography

The Elk, Spring, and upper James River Basins lie within an area described as the

"Springfield Plain" by Sauer (1920). This area forms the western boundary of the Ozark Highlands. It is a gently sloping plain covered with fertile soils. The streams flow in rather steep-sided valleys, and the area in general appearance and condition is like the plains of eastern Kansas. The streams receive water from the many springs of the area. Two main centers of population in the region are Springfield and Joplin. Springfield has a population of about 100,000 and the Joplin area is in excess of 40,000. Aside from the population centers, the main land use is agricultural. About 80 percent of the land outside the cities is used for farms and forest land (Collier, 1955).

The lower James River, including its tributary streams, lies in the region called the "White River Hills" by Sauer (1920). This region is characterized by high buttes, innumerable glades, and valleys cut by drainage lines, making this area of the state second in relief only to east-central Missouri. There are no major cities in this region; the largest towns have populations of about 1,500. About 85 percent of this area is farmland, most of which is still woodland of the oak-hickory forest type. Streams are clean, swift, and partly spring fed.

Elk River Basin

The survey of the Elk River Basin included stations on Little Sugar (Els - 1), and Big Sugar (Ebs - 1) creeks, which enter Missouri from Arkansas and join to form the Elk River at Pineville, Missouri (Figure 1). Station Els - 1 was located at the Highway 71 crossing near Caverna, Missouri. Little Sugar Creek is a clean Ozark stream which is of high quality as indicated by the high coefficients of similarity (Table 1) to other stations in the Elk River Basin. The diverse benthic fauna consisting of 66 types with 38 (58 percent (Table 2) of the organisms being members of the clean-water groups. Big Sugar Creek, station Ebs - 1 located south of Powell on Highway "E", was very similar to Little Sugar Creek. The water quality of Big Sugar Creek was quite high as indicated by the benthic fauna. Station Ebs - 1 was of high quality as indicated by 61 types of aquatic life, of which 34 or 56 percent of the types were members of the clean-water groups.

Samples were also collected from Indian Creek, another large tributary of the Elk River. The riffle at station Ei-1, located southeast of Anderson on Highway 76, was composed of a high percent of gravel. Extensive gravel bars indicated the instability of the creek bottom in the upstram reach of Indian Creek. The reduced

stability of the riffle at station Ei-1 probably contributed to the slightly low number of types of organisms present (56): however, the presence of 33 clean-water types (59 percent) is indicative of high-quality water. In spite of the large quantities of shifting gravel, one specimen of the Unionidae group was found during the spring collection.

Station Ei-2, located about eight miles downstream from Ei-1, was the only station sampled in the Elk River Basin which contained fewer than 50 percent clean-water organisms (47 percent). The apparent reasons for the reduced clean-water fauna at station Ei-2 was organic pollution from a poultry processing plant and cheese plant at Anderson. In addition to these pollution sources, a gravel dredging operation caused excessive turbidity in Indian Creek during its intermittent operation. The reduction in clean-water types was not in one specific order (stoneflies, mayflies, or caddisflies) but was a reduction of a few types from each group. Two mayflies of the family Caenidae, Caenis sp., and Tricorythodes sp. were very abundant at station Ei-2. According to Hynes (1963) the mayfly Caenis sp. can tolerate silt while other mayflies are less tolerant of silted conditions.

The main stem of the Elk River was sampled at three locations, E-1, E-2, and E-3. Station E-1, located at the Highway 71 crossing was of high quality, as indicated by 61 percent clean-water organisms. In spite of large quantities of gravel, the benthic fauna had high coefficients of similarity when compared with other Elk River stations. The riffle at station E-2 was composed mainly of shingle-type rubble. This riffle harbored 58 percent clean-water types and had very high coefficient of similarity values when compared with other stations in the basin.

Station E-3, the downstream station on the mainstem of the Elk River, was located at the Highway 43 crossing. The Elk River at this point has grown from an Ozark stream with a fall discharge of about 35 cubic feet per second to a large, clear river with a discharge of over 150 cfs. The increased volume had not caused significant changes in the benthic community. Coefficients of similarity remained high when compared with even the smallest streams sampled. Added evidence of the high water quality was the presence of 54 percent clean-water organisms.

Buffalo Creek, a tributary of the Elk River, was sampled near Tiff City at the Highway 43-76 crossing. Buffalo Creek is a spring-fed, gravel bottomed stream. Spring-fed streams quite often have a fauna that can be misinterpreted to be polluted because they do not harbor as diverse a fauna, and the population are

often dominated by a few taxa. Station Eb-1 was the only station in the Elk River Basin to have a coefficient of similarity of less than 50. A coefficient of similarity of 48 was obtained in the comparison of the Buffalo Creek station with station Ei-2, the only station with less than 50 percent clean water types. The low coefficient of similarity is probably a combination of the effects of the pollution at Ei-2 and the spring-stream fauna found in Eb-1.

James River Basin

The James River originates in a rather narrow watershed and gathers its waters from short tributary streams in its upstream reach. Longer and consequently larger tributary streams contribute to the James River in its middle and downstream reach (Figure 2). Generally, the topography of the area is plain like, but the relatively clear water and presence of large quantities of chert gravel in the riffle bottom is suggestive of an Ozark stream. Twenty riffle stations were located in the James River basin, eight on the main stem of the river and twelve on tributary streams.

Upper James River

The upper James River included four stations of the main stem (J-1 through J-4) and stations on Pearson and Sequiota Creeks in Greene County. Station J-1 was located about one mile west of the Greene-Webster County line on a riffle which was moderately stable and composed of more than 50 percent gravel. Like the headwaters of the typical Ozark stream, the James River at Station J-1 was clear, with large areas of unstable gravel along the shoreline. The benthic population at Station J-1 was composed of 65 types of organisms of which 40 (62 percent) were members of the clean-water groups (Table 3). High coefficients of similarity with other high-quality headwater streams is indicative of the condition of James River at Station J-1 (Table 4).

Station J-2, located upstream from Highway D crossing about five miles east of Springfield, harbored a benthic fauna representative of good quality water. Of the 70 types of organisms collected from Station J-2, 37 (53 percent) were members of clean-water groups. Like Station J-1, J-2 was located on a moderately stable riffle composed of a high percentage of gravel. The coefficient of similarity calculated for J-2 was highest in the comparison with Stations J-1, J-3, and J-4.

The substrate at Station J-3 was somewhat different than that at Stations J-1 and J-2. At Stations J-3, the substrate was composed of a high percentage of

bedrock overlain with gravel and rubble. The presence of less than 50 percent clean-water organisms (46 percent) is overshadowed by the high coefficients of similarity with other clean-water stations. The high similarity of Station J-3 to its neighboring stations is indicative of good water quality. The reduced percentage of clean-water types at Station J-3 could be attributed to substrate and water velocity differences.

Station J-4, located two miles upstream from the confluence of James River and Wilson Creek, is the last station on the main stem of the James River which is unaffected by pollution from Springfield. Below Wilson Creek, problems vary from fish kills to symptoms indicative of excessive nutrients. Station J-4 harbored the most diverse fauna, represented by 85 types of benthic invertebrates. The excellent substrate, about 70 percent rubble, 20 percent gravel and 10 percent boulders, no doubt contributed to the diversity represented in the collections. Of the 85 types present, 41, or 48 percent of the types represented, were members of clean-water groups. A further discussion of the effects Wilson Creek has on James River can be found along with the material presented for Station J-5.

Pearson Creek drains an area about three miles east of Springfield which is heavily used for dairy farming. The benthic fauna of Pearson Creek, sampled at Highway D, was composed of 56 percent clean-water types. The low coefficients of similarity which were obtained for Station Jp-1 can be attributed to abnormally high numbers of certain groups. The presence of large quantities of algae and watercress in Pearson Creek is indicative of a large quantity of spring flow. The ground water flow in Pearson Creek stimulated the number of snails, Goniobasis sp., and could possibly have an effect on the unusual numbers of the mayfly Baetis sp. The unusual high numbers of these organisms plus several smaller variations are the cause of the low coefficients of similarity.

The Sequiota Creek Station, Js-1, located near the junction of Highways 65 and 60, 3 miles south of Springfield, contained a fauna which indicated a disturbed situation. Previous records on Sequiota Creek indicate occasional pollution problems which have resulted in fish kills. The low coefficients of similarity with clean-water stations and presence of only 42 percent clean-water organisms indicate a degree of pollution in Sequiota Creek.

Middle James River and Wilson Creek

A discussion of the water quality of the middle reach of James River without including Wilson Creek would be egregious. Wilson Creek is not only one of the largest tributary streams in the James River System, but it also drains an area with a population of approximately 100,000. The effect of Wilson Creek on James River is well illustrated when Station J-4 is compared with J-5. Station J-5, located about six miles downstream from the confluence of Wilson Creek and James River, harbored only 52 types of benthic organisms, of which 22 (or 42 percent) were clean-water organisms. All coefficients of similarity calculated for Station J-5 in comparison with high quality headwater stations yielded low values.

In July of 1966 following a fish kill below Wilson Creek, benthos samples were taken at Stations J-4 and J-5. The kill was caused by low dissolved oxygen, originating in Wilson Creek. In July, 1966, Station J-4 (above Wilson Creek) harbored 37 types of organisms of which 17 (46 percent) were clean-water types, indicative of good water quality. At Station J-5, the benthic fauna following the fish kill consisted of 22 types, of which only 5, or 23 percent, were representatives of the clean-water groups. A comparison of summer benthos populations at Stations J-4 and J-5 showed little change in the types of organisms collected in 1964 and 1966 at J-4, but a significant reduction in clean-water types at J-5 was apparent following the fish kill (Table 5). In the 1964 collection, 13 types of mayflies were collected at J-5; however, in 1966 following the kill, only 4 types of mayflies were collected. Caddisflies were represented by one genus (Cheumatopsyche sp.) at Station J-5 in 1966, compared with two genera in 1964. In both the 1964 and 1966 collections, Station J-4 had five caddisflies represented in each collection. Stoneflies are of little significance in mid-summer collections; however, one species (Neoperla clymene) was collected at Station J-4, and none at Station J-5.

Stations J-6 through J-8 showed a gradual improvement in the composition of the benthic community at Station J-6, located 6 miles east of Hurley and about 14 miles downstream from Wilson Creek, was represented by 67 benthic types, of which 32, or 48 percent, were clean-water types. This is a considerable improvement over the benthos population sampled at Station J-5. Part of the improvement, no doubt, is due to natural stream processes, including the inflow of good quality water from Finley Creek about three miles upstream. The improved condition at Station J-6 is also indicated in the comparison of coefficients of similarity for Station J-6 with the coefficients obtained for the comparisons with Station J-5.

The coefficient of similarity obtained in the comparison of Station J-4 with J-6 was 60, while the comparison of Stations J-4 and J-5 yielded only 44. Other Stations were not as drastically different, but all comparisons of Station J-5 with clean water stations yielded lower readings than the same comparisons with Stations J-6, J-7, or J-8.

The water quality at Station J-7, which was located 5 miles east of Elsey on Stone County Highway AA was improved over Station J-5, and in some aspects, improved over J-6. The number of types of benthic macroinvertebrates found in samples from Station J-7 was slightly higher than Station J-6. At Station J-7, 72 types of life were identified, of which 34, or 47 percent, were clean-water types. An unusually high coefficient of similarity was obtained in the comparison of Station J-7 with Jp-1. The data obtained in the coefficient of similarity was affected by high numbers of Chironomidae at each station. The contribution of this one group to the analysis was enough to raise the similarity of these apparently different stations.

The final station of the main stem of the James River was Station J-8, located about two stream miles below Galena. The population of macroinvertebrates as represented by the samples collected was of good quality in percent of clean-water organisms and coefficients of similarity. The riffle at Station J-8 was composed of a high percentage of rubble and boulders. Fifty-two percent of the types of organisms collected were clean water types. The coefficients of similarity were high in all comparisons with the exception of Stations Jp-1 and Js-1. High similarity with stations as diverse as Station J-1 and J-5 seems improbable. The pollution which enters the James River at Wilson Creek is probably "assimilated" at Station J-8, and aside from the large quantities of algae, the river is in good condition.

Wilson Creek

Wilson Creek was sampled at three locations, all below the Springfield sewage treatment plant. According to recent estimations, the Springfield treatment plant treats wastes of 220,000 population equivalents. Station Jw-1, about two miles downstream from the treatment plant, harbored 7 types of life, of which only 2 (29 percent) were clean-water type organisms. The coefficients of similarity for the comparison of Station Jw-1 with unpolluted tributary stream stations were extremely low. As discussed earlier, the coefficient of similarity will be above 50 when two good

quality stations are compared. The lowest value possible would be in the range of 01, which was obtained in the comparison between Station Jw-1 and a station of Flat Creek. As expected, stations polluted by similar types of wastes would have high coefficients of similarity. Stations Jw-1 and Jwsp-1 had the highest coefficient of similarity in the James River Basin, an 82. Station Jwsp-1 was located in the spring flow from Rader Spring which consists mainly of the treated sewage from Springfield which enters the groundwater below the treatment plant and flows from the ground two miles downstream and about twenty-five feet from Station Jw-1. The water of Rader Spring harbored only 4 types of life, worms (Oligochaeta), leeches (Hirodinea), a snail, Physa sp., and midge larvae (Chironomidae). All of these creatures are extremely tolerant of organic type pollution, and all but the leech were very abundant in the flow of Rader Spring.

Station Jw-2, located at the last county road crossing of Wilson Creek above the James River and about 4 miles downstream from Station Jw-1, harbored a benthic population indicative of polluted water. The presence of only eleven types of life, two of the clean-water type, is indicative of the impact a heavy populated and industrialized area can have on stream life. The high coefficients of similarity between the Wilson Creek stations and extremely low values obtained when comparing the Wilson Creek stations with Station J-1 and J-6 (Table 4) gives an indication of the severely polluted condition of Wilson Creek. It is interesting to note that thirty years ago, when the population of Springfield was nearly 70,000 Sullivan (1933) made a survey of James River, including Wilson Creek. In his report to the Missouri State Game and Fish Commissioner, his observations made on Wilson Creek near its mouth are recorded. Dr. Sullivan states, "Animal life was found to be very abundant, even those forms which require large quantities of oxygen for their existence. This is a very good indication that the injurious gases which result from the disposal of sewage waste are not present in these waters." In contrast with these records, we have frequent fish kills, and the benthic fauna collected during the water quality survey clearly indicate that Wilson Creek is severely affected by pollution from Springfield. It is also apparent from the data presented and previously discussed that Wilson Creek has an adverse effect on aquatic life in James River.

Finley Creek

The Finley Creek watershed parallels the Upper James River in its westerly direction flow. Finley Creek is a large tributary which drains a more sparsely settled area than the upper James River. Station Jf-1 was located above all the towns in the watershed and about 2 miles upstream from the town of Linden. Station Jf-1 had a benthic fauna

represented by 69 types, of which 40 (58 percent) were clean-water types. The high coefficient of similarity with Station J-1 is further evidence of the high quality water at these stations (Table 4). Station Jf-2 was located downstream from Highway 125, below Lindenlure Lake near the town of Linden. This station was also of high water quality, as indicated by the presence of 63 types of life, 30 or 48 percent of which were members of the clean-water groups. The reduced number of organisms could be attributed to the presence of Lindenlure Lake, immediately upstream, and the partial bedrock substrate similar to that at Station J-3.

The only serious source of pollution in the Finley Creek Basin was located above Station Jf-3. The station, located upstream from Highway 65, was polluted by cheese plant wastes and municipal wastes from Ozark which entered the creek about a half-mile upstream. The organic pollution was apparent from the appearance of the creek, and growths of sewage fungus (Sphaerotilus sp.) in parts of the riffle. The benthic community showed the effects of the pollution. Of the 25 types of benthic organisms collected, only 7 (28 percent) were clean-water organisms. The pollution problem was most serious during the first three sampling periods. The cheese plant was providing some treatment during the spring collection period, but the water quality at Station J-3 was still low due to the waste discharges upstream.

Finley Creek at station Jf-4, located at the Highway 160 crossing six miles downstream from Jf-3, was much improved over the conditions found at Jf-3. The total types of organisms collected rose from the 25 collected from Station Jf-3 to 61 at Jf-4. The percent of clean-water organisms was quite low, 38 percent. The coefficients of similarity calculated for Station Jf-4 were improved in comparison with clean water streams. In spite of a good rubble and gravel substrate, the riffle at Station Jf-4 harbored only two members of the order Plecoptera (stonefly), Allicapnia sp., and Isoperla sp. At Station Jf-2 above the pollution, six members of the Order Plecoptera were collected. The reduction in the clean water groups from Station Jf-2 to Station Jf-4 was mainly in the Order Plecoptera; however, several members of the Order Ephemeroptera were also absent from Station Jf-4.

Crane Creek

Crane Creek originates in the western part of the James River Basin. The creek flow is made up of a large quantity of spring water which enters Crane Creek from its tributary, including Spring Creek. The station located on Crane Creek (Jc-1) about five miles east of Elsey, contained 64 types of life, of which 30 (or 47 percent) were clean-water types. The coefficients of similarity obtained in the comparison of Station

Jc-1 with other clean-water stations was quite high, indicating good water quality.

Flat Creek

The stations located on Flat Creek, Stations Jfl-1 and Jfl-2, were of good quality. Stations Jfl-1, located about two miles north of Cassville, harbored 58 types of benthic macroinvertebrates, of which 29 (50 percent) were clean-water types. Station Jfl-2, located east of Jenkins on Highway EE, harbored the same number of types and percentage of clean water organisms as Station Jfl-1; however, the coefficient of similarity was low. The reduced similarity could be due to the lagoon effluent from Cassville, but a review of the data revealed the low similarity to be due to specific differences. Station Jfl-1, in comparison with Station Jfl-2, harbored few snails, Goniobasis sp., many Isopods, Lirceus sp., and dissimilar coefficients of similarity. When the effect of the lagoon effluent is combined with substrate and flow variations, low coefficients of similarity are obtained for Stations Jfl-1 and Jfl-2.

Spring River Basin

The Spring River in southwestern Missouri is more typical of a plain-type river than the Elk or James River. The area which it drains has less relief, and the waters are more turbid than Ozark-type streams. In the north and western portion of the basin, the valleys are wide and much of the land along the river is used for agriculture. In this reach, the Spring River is quite typical of an eastern Kansas plains river.

The Spring River drainage is more heavily populated than the Elk or lower James River Basins. Several cities have populations of more than 2,000 and the Joplin area has a population in excess of 40,000 (Figure 3). Industrialization of the area is moderately heavy with the Joplin-Webb City area having a concentration of lead and zinc mines and other industries.

The tributaries of the Spring River which were sampled during this survey include, from east to west, Honey Creek, Williams Creek, North Fork of Spring River, Center Creek, Turkey Creek, and Shoal Creek. Honey Creek and Williams Creek are small tributary streams in the Upper Spring River. The North Fork of Spring River is a major tributary stream which drains the northwest portion of the basin. The North Fork drains an area of moderate population and low relief.

Center Creek, south of the main stem has nearly the same river miles in Missouri as Spring River. Center Creek flows along the north edge of the Joplin-Webb City area where it receives industrial and sanitary wastes.

Turkey Creek, a small interstate tributary stream flows through the Joplin area and receives treated sanitary wastes and industrial wastes.

Shoal Creek, a major interstate tributary of Spring River forms the southern boundary of the Spring River Basin in Missouri. Shoal Creek drains the northern part of the City of Neosho and southern part of the Joplin area. Both Neosho and Joplin utilize Shoal Creek for municipal water supply.

Upper Spring River

The Spring River rises from several springs near the town of Verona. Station S-1 located upstream from Verona at the Highway P crossing had a variety of organisms which indicates good water quality. However, the absence of members of the Order Plecoptera and the snail, Goniobasis sp., cause some suspicion. The absence of stoneflies could be attributed to the high percent of gravel (80 to 90 percent) in the riffle. However, the absence of the snail, Goniobasis sp., at this station causes suspicion about the discharge of toxic materials from the fish hatchery at the head of the river. In the final analysis of Station S-1, the presence of 50 types of life, of which 24 (48 percent) were clean-water types indicates good water quality (Table 6). The coefficients of similarity for Station S-1 also appear to be good (Table 7) but the population structure and high similarity with polluted stations raises some unanswered questions.

Downstream from the town of Verona Station S-2 was affected by periodic discharges from an industrial complex located in Verona. The overall totals for Station S-2 indicate good water quality by the presence of 49 types of life, and 24 clean-water types. However, this is misleading; during the winter collection, 21 types of life were found but only 4, or 19 percent were clean-water types. There was an unusual biological growth on the riffle bottom and the water appeared oily during the winter sampling period. During the fall collection, sewage fungus, Spaerotilus, sp., was observed in parts of the riffle. The summer and spring collection indicated the creek to be in good condition, at least part of the year. The coefficients of similarity for Station S-2 were lower for most stations indicating the polluted nature of the Spring River at this station. The periodic problems and presence of the industrial

complex suggest that it will be desirable to check this station for improvement or degradation of the water quality.

At Station S-3, about three miles downstream from Verona, the water quality as indicated by benthic macroinvertebrate samples was high. The total number of types, 62 was considerably higher than the previous stations. The presence of 31, or 50 percent clean water types and the balanced population throughout the year are indicative of the high water quality at Station S-3. The coefficients of similarity for Station S-3 when it was compared with other clean water stations were high. High similarity was noted between Station S-3, S-4, and S-5.

Honey Creek is the first sizable tributary stream to enter the Upper Spring River. Honey Creek heads near the town of Marionville, flows north and west for about 15 miles before entering the Spring River at Hoberg. The creek was sampled east of Hoberg, upstream from a county road crossing. The gravel riffles harbored a sparce population of benthic organisms. The presence of only 31 types of organisms could create some suspicion, however, 18 or 58 percent were clean-water types eliminating most suspicion of pollution problems. The limited fauna of Honey Creek is most likely due to the gravel substrate and size of this tributary stream. The coefficients of similarity calculated for Station Sh-1 were all low with the exception of the values obtained when Sh-1 and S-1 were compared. These stations were similar in substrate but the benthic population at Station Sh-1 varied from 8 types of life during the winter collection to 19 types of life collected during the fall collection. The water quality at Station Sh-1 was generally good but the station did not harbor a diverse fauna.

Williams Creek heads in a short dendritic watershed east of Mt. Vernon. The water quality of Williams Creek is poor as indicated by the presence of only 16 types of aquatic life, one of which (6 percent) was a clean-water type organism. The station, Sw-1, located about one mile downstream from Mt. Vernon was polluted by poorly treated sewage and wastes from industries in Mt. Vernon. The rubble and gravel bottom was covered with dense growths of filamentous green algae and diatoms. Large numbers of minnows were present in the pools near the sample site. All coefficients of similarity calculated for station Sw-1 with the exception of the comparison with S-1 were quite low, indicating poor water quality.

The Spring River at Station S-4 located about two miles north of Stotts City was of relatively good quality. The presence of high numbers of pollution-tolerant organisms such as Oligochaeta, Hirudinea, and Chironomidae indicates the impact the pollution

of Williams Creek has on Spring River. On the positive side, Station S-4 harbored 55 types of life, somewhat lower than Station S-3. Of the 55 types, 28 or 51 percent were clean-water types which indicates the water quality at Station S-4 to be good in spite of the problem in Williams Creek. Station S-4 had a high coefficient of similarity with Station S-1. This could be attributed to the presence of a slight pollutional effect from a fish hatchery and the high volume of spring flow at Station S-1, and the impact of polluted flows from Williams Creek on Station S-4. Station S-5, about 5 miles upstream from Carthage, was located on the remains of a mill dam, a very stable, boulder, rubble, and gravel riffle. The substrate provided excellent habitat for 73 types of benthic life, the second highest number of types found in the Spring River Basin. Of the 73 types, 40 or 55 percent of those represented were members of clean-water groups. The large rubble harbored a great variety of Plecoptera (stoneflies) and Tricoptera (caddisflies), and large numbers of the hellgrammite, Corydalus cornutus. The coefficients of similarity calculated for Station S-5 indicated, as do other data, that Station S-3 was most similar to S-5. Both stations harbored more than 60 types of life and both were considered to be of high quality based upon benthos data.

Lower Spring River

The lower Spring River includes mainstem Stations S-6 through S-8 and two stations on the North Fork of Spring River, Snf-2 and Snf-3. The lower Spring River differs from the Elk, James, or upper Spring River. The lower Spring is a plains river; broader, more turbid and generally of a lower velocity of flow.

Station S-6 located about two miles northwest of Carthage was affected by sewage and industrial wastes discharges. The Carthage sewage treatment plant and marble quarry located about two miles upstream were the apparent cause for the lower water quality. The benthic fauna at Station S-6 consisted of 45 types of life, of which, only 13 or 29 percent were members of the clean-water groups. The turbid water discharged from the marble quarry and polishing operation caused a milky turbidity and undoubtedly contributed to the decline of the benthic population. The turbid condition is indicated by the unusually high numbers of mayflies of the family Caenidae (Caenis sp. and Tricorythodes sp.). The coefficients of similarity calculated for Station S-6 were low when this station was compared with clean-water stations such as Station S-3. A significant reduction in the number of types of life, from Station S-5 (73 types) to 45, was also apparent. This reduction was followed by what appeared to be a gradual recovery downstream.

Station S-7 was located about 14 miles downstream from Carthage and just outside of the town of Galesburg. The water quality at Station S-7 showed considerable improvement over that at Station S-6. Station S-7 harbored 50 types of benthic life, of which 21, or 42 percent were clean-water types. Coefficients of similarity calculated for Station S-7 was high when this station was compared with Stations S-4, S-5, and S-6. Based upon the improved percentage of clean-water organisms and population diversity, Station S-7 was considered to be of good water quality.

The last station on the main stem of Spring River was located about one-half mile inside Missouri and about two river miles downstream from Highway 171. Water quality at this station was quite good as indicated by the benthic organisms collected. The samples collected contained a total of 52 types of life, 23 (44 percent) of which were clean-water organisms. The Spring River at Station S-8 harbored a diverse benthos population including four types of mussels. Coefficients of similarity calculated for Station S-8 were generally low. The highest values were obtained in a comparison with Stations Ss-4 and Ss-10 (Shoal Creek), and Station S-7. Because of the fairly diverse benthos population, and similarity to clean-water stations on Shoal Creek, Station S-8 was considered to be of high water quality.

North Fork Spring River

The North Fork of Spring River cannot be considered high quality water based upon parameters used in this survey. At Station Snf-2, located 5 miles south of Lamar at Highway 71, a total of 44 types of life were collected, of these only 14 or 32 percent were clean-water types. These low values would indicate a pollution problem in the Elk, or James River Basins, but the North Fork of Spring River is a prairie stream. It has a large watershed, mud banks, more turbid water and few good riffles. It is likely that the presence of sewage treatment facilities on the North Fork at Lamar, and Golden City also have some affect on the water quality. It is impossible at this time to separate the environmental factors from possible pollution.

Station Snf-3 was located on a stable riffle which had an excellent substrate for benthic macroinvertebrates. The riffle was located on private property about three miles east of Asbury, near Georgia City. This station showed some improvement in the benthic population over the previous station. Station Snf-3 harbored only 44 kinds of life, but 17, or 40 percent, were clean-water types. It is difficult to determine if the improved percentage of clean water organisms is due to recovery from wastes entering North Fork above Station Snf-2 or the more favorable riffle substrate at Station Snf-3. The coefficients of similarity indicate the improved

situation at Station Snf-3 over Snf-2. Although the values were still low, the improvement ranged from about 10 to 15 units.

Center Creek

Center Creek heads east of Sarcoxie, Missouri, and flows westerly to its confluence with Spring River just inside the Missouri state line. A gravel bottomed stream with low flow made up of spring water, the upper reach of Center Creek is of high quality. The lower reaches are characterized by moderately clear waters and reduced benthic populations due to the presence of known pollutants. Eight stations were located on Center Creek (Figure 4).

Station Sc-1, located 1/10 mile east of Sarcoxie on Business 44, had high water quality as indicated by the seasonal benthos samples. Of the 60 different types of benthic life identified, 30 (or 50 percent) were clean-water types. The coefficie of similarity (Table 8) was high when Station Sc-1 was compared with other clean-water stations on Center Creek.

Station Sc-2, located about 2 miles south of Reeds on Highway 37, was of high quality as indicated by the benthic community. Although the riffle at Stations Sc-1 and Sc-1 were quite similar in composition, the coefficient of similarity (52) was not high. The greatest differences between the samples was the presence of 5 types of Plecoptera (stoneflies) at Station Sc-1 and 9 at Station Sc-2, and the presence of 5 types of Odonata (dragon and damselflies) at Station Sc-1 and only 2 at Station Sc-2. Station Sc-2 harbored 65 kinds of life, of which 35 (or 54 percent) were clean-water types (Table 9). It is likely that the high percentages of spring water and presence of large quantities of emergent vegetation at Station Sc-1 have some bearing on the differences in the benthic communities of Sc-1 and Sc-2.

Station Sc-3, located 3 miles south and 2 miles west of Carthage, harbored the most diverse benthic fauna found in the eight stations located on Center Creek. Although the coefficient of similarity obtained from the comparison of Station Sc-3 and Sc-1 was lower than expected, the similarity of Station Sc-3 and Sc-2 was quite high. The high water quality and favorable substrata at Station Sc-3 is best exemplified by the fact that it harbored more types of clean-water life than any of the 24 stations in the Spring River basin, with the exception of Station S-5 which also harbored 40 clean-water types. The total types of life, 81 collected from Station Sc-3 was the most collected from any station in Spring River.

Station Sc-4, located about 2 miles east of Carterville on Highway HH, downstream from severely polluted Grove Creek, harbored a relic population. The pollution on Grove Creek is from a large chemical manufacturing complex which discharged large amounts of ammonia (NH_3) and low pH water to Grove Creek. At Station Sc-4, only 19 types of life were collected (Sc-3 had 81 types). Of the 19 types collected at Sc-4, several were suspected to have resulted from drift. This is particularly true of the 10 clean-water types, for in succeeding stations the number of clean-water types is reduced. At Sc-5 only 6 clean-water types were collected, and 4 at Sc-6. Another indication that some of the clean-water organisms collected from Station Sc-4 were drift is the fact that four taxa were represented by one individual and two other taxa were represented by two individuals. This is far from a normal population. The coefficients of similarity for Station Sc-4 when compared with Stations Sc-1, Sc-2, and Sc-3, were low. However, high similarity was obtained in the comparison of Station Sc-4 with other polluted stations.

From Grove Creek downstream, Stations Sc-4 through Sc-8, little change in the benthic community was noted. Station Sc-5, located 2 miles north of Carterville harbored 15 types of life, of which 6 were clean-water types. Station Sc-6, located ½ mile south of Oronogo, was not improved, it harbored 19 types of life, of which 4 were clean-water types.

One interesting observation made in the polluted zone of Center Creek was the presence of the beetle (Coleoptera), Berosus sp. This organism, uncommon in general collections, was found in good numbers at Station Sc-4, and subsequent stations downstream. A search of available literature did not yield an answer for the increased numbers, however, it is probable that reduced predation, plus a good food supply, combined to rationalize their presence.

Station Sc-7, located downstream from Highway 171, about 2 miles north of Airport Drive, harbored a benthic community similar to that already discussed at Stations Sc-5 and Sc-6. The similarity of Station Sc-7 to Sc-8 was quite high as indicated by the coefficient of similarity. Station Sc-8 was located about one mile upstream from the Missouri-Kansas state line. The pollution which enters Center Creek at Grove Creek plus water from abandoned zinc mines had a severe effect on the benthic community at Station Sc-8.

Shoal Creek

Shoal Creek, the southern most tributary of Spring River studied in this survey heads in Barry County near the towns of Exeter and Monett. Much of the low flow in Shoal Creek is spring water and the creek is utilized for municipal water supply by Neosho and Joplin.

The general water quality of Shoal Creek was found to be high. Three of the collection sites established in a survey of Shoal and Turkey Creeks in 1957-1959 (Neal, 1961) were used for this survey.

Station Ss-3, located downstream from the Highway 60 crossing, harbored 67 types of benthic life, of which 34 (or 52 percent) were clean-water types. The water quality of Station Ss-3 was quite high as indicated by the diverse benthic fauna and the high coefficients of similarity obtained when it was compared with other clean water stations in the basin.

Station Ss-4, located near Ritchey downstream from Highway W crossing, harbored 65 types of life, 32 of which were clean-water types. The water quality at Station Ss-4 was considered to be good.

Station Ss-10 was located about 35 miles downstream from Station Ss-4, and about two miles west of the town of Shoal Creek. This station provided a check on Shoal Creek about three miles upstream from the Missouri-Kansas state line. Although Shoal Creek had increased in size and stability, the benthic fauna was composed of a similar number of taxa. Station Ss-10 harbored 61 types of life, of which 29 were members of the clean-water groups. The coefficients of similarity for the comparison of Station Ss-10 with other clean-water stations was quite high.

Turkey Creek

Turkey Creek is a small interstate stream which heads several miles east of Joplin and flows westward through part of the city. Turkey Creek was sampled at one station (St-9), established during the 1958-1959 survey of Shoal and Turkey Creeks (Neal, 1961). The station, located at Highway P was about 3 miles downstream from the Joplin sewage treatment plant. As described by Branson, 1966, Turkey Creek is severely polluted. At Station St-9, only 9 types of life were collected in this survey, of these 3 were clean-water types. The 9 types of life is the fewest collected in the Spring River Basin. The coefficients of similarity for Turkey Creek are

extremely low when compared with clean-water streams in the Spring River Basin. Turkey Creek is probably our most polluted interstate stream.

VI: PHYSICAL, CHEMICAL AND BACTERIAL QUALITY OF SURFACE WATERS IN THE JAMES, ELK, AND SPRING RIVER BASINS

VI. PHYSICAL, CHEMICAL, AND BACTERIAL QUALITY OF SURFACE WATERS JAMES, ELK AND SPRING RIVER BASINS

FACTORS INFLUENCING WATER QUALITY

Many factors influence the water quality of streams. Natural as well as man-made influences are involved.

Rainfall influences water quality by its absorption of various gases as it falls through the atmosphere. Carbon dioxide is commonly associated with rainwater and further affects runoff as it produces certain chemical reactions in various rock and soil types.

Land runoff greatly determines surface water quality as it is influenced by both man-made and natural factors. Some minerals are carried to streams in runoff from rocks and soils. In addition, the water quality may be altered by substances associated with disturbed land. Runoff from certain mined areas commonly contains a significant concentration of heavy metals and acid producing material. Various forms of nitrogen and other substances are added to runoff from decomposing organic matter of both plant and animal origin. Fertilized agricultural lands yield significant quantities of phosphates, nitrates, and numerous trace minerals. The most noticeable effect that runoff has on surface water quality is the turbidity that commonly results in most areas. Many substances are associated with the suspended and colloidal material in turbidity which may produce water quality changes.

In areas with underground characteristics such as those of the land in the James, Elk, and Spring River Basins, groundwater may have considerable influence on the quality of surface waters. Surface waters intersecting the groundwater table or receiving spring discharges are affected in several ways. Depending upon underground strata, various minerals and trace elements are dissolved. Groundwater properties of this nature commonly influence the specific conductance, total hardness, silica, iron, and several other parameters. Temperature of the groundwater tends to remain constant and not to be altered by ambient air temperatures as are surface waters. Where groundwater contributes a large portion of the total flow in a stream, the temperature of the stream will avoid extremes caused by summer and winter ambient air temperature variations.

Geological characteristics of a watershed, as previously noted, partly determine

the quality of surface waters. Runoff, groundwater inflow, and geological characteristics are all interrelated as an influence on water quality.

Reservoirs and lakes located in a watershed have a definite effect on water quality. The quality of the water in the impoundment, and the impoundment's discharge, may both be altered. The change of a free flowing stream to a quiescent body allows a change in biological habitat and is influenced differently by certain physical elements, both of which are relative to water quality. The quality of the water discharged from an impoundment is determined substantially by the discharge level. The stratification of various physical and chemical components, which results from the stratification of water contained by the impoundment itself, is reflected in the discharge at various levels in impoundments.

Available sunlight can affect water quality of a stream in some instances. In streams with a high degree of photosynthetic activity a variation in available light by shading and diurnal fluctuations can cause a significant change in several parameters. Most notable of these parameters is dissolved oxygen. Accompanying this change in dissolved oxygen, a change in pH and alkalinity is commonly observed.

Water temperature is the primary physical factor which determines the amount of oxygen which can become dissolved and remain dissolved. Saturation of dissolved oxygen occurs at a considerably lower value in warm water. As previously mentioned the natural influences on water temperature are principally ambient air temperature and groundwater influence. Waste discharges may also be an influence on water temperature, especially when the receiving stream provides a small dilution ratio.

Water turbulence created by a fast moving stream with numerous riffles can have an effect on water quality, particularly dissolved oxygen. In riffles with a steep gradient, a physical addition or depletion of oxygen may occur. This is dependent upon the oxygen saturation as it enters such a riffle. Aside from oxygen fluctuations by turbulence in a riffle, the oxygen levels may be increased by photosynthetic activity of attached algae which normally occupy riffle areas.

Man-made influences, most notable in the form of waste discharges, affect the quality of surface waters in numerous ways.

The effects of industrial wastes represent a much broader spectrum of influences than those of most municipal wastes. Industrial wastes may significantly alter the chemical composition of streams or may only cause a small variation such as a change in the water temperature. Some wastes from industry are degradable by conventional treatment used for organic wastes, while others require a more sophisticated type of treatment.

Domestic waste from municipal discharges affects surface waters in varying degrees depending on the type of treatment, the dilution by the receiving stream, and several other factors. The parameter most commonly increased is the coliform bacteria concentration. Other parameters which may increase with the addition of domestic wastewater are sodium and potassium, nitrates, nitrites, ammonia, chlorides, specific conductance, phosphates, and detergents. (See Table VI-2) Dissolved oxygen can be affected by the entrance of municipal waste discharges. This is dependent upon the degree of oxidation of the organic constituents contained in the waste.

Manipulation of natural conditions in and near a stream can alter water quality, particularly by increasing turbidity. Construction in the area of the stream plus the removal and washing of gravel in or adjacent to a stream are common examples. Areas that have been surface or strip-mined in a watershed may also present a definite effect of this nature.

Other influences much more subtle than the ones discussed are involved in the total aspect of surface water quality. These for the most part, however, are of minor significance.

TABLE VI - 1 SUBSTANCES OCCURRING IN NATURAL WATERS

ORIGIN	SUSPENDED	COLLOIDAL	GASES	NON-IONIZED SOLIDS AND DIPOLES	POSITIVE IONS	NEGATIVE IONS
From mineral soils and rocks	Clay, sand, other inorganic soils	Clay SiO_2 Fe_2O_3 Al_2O_3 $MnO2$	CO_2		$Ca++$ $Mg++$ $Na+$ $K+$ $Fe++$ $Mn++$ $Zn++$ Other trace metals	HCO_3^- $Cl-$ SO_4-- NO_3-- CO_3-- $HSiO_3-$ H_2BO_3- HPO_4-- H_2PO_4 $OH-$ $F-$
From the atmosphere			N_2 O_2 CO_2 SO_2		$H+$	HCO_3- SO_4--
From organic decomposition	Organic soil (top soil), organic wastes	Vegetable coloring matter organic wastes.	CO_2 NH_3 O_2 N_2 H_2S CH_4 H	Vegetable coloring matter, organic wastes.	$Na+$ NH_4+ $H+$ $K+$ Trace metals	SO_4-- $Cl-$ HCO_3- NO_2 - NO_3- $OH-$ $HS-$ $S--$ Organic radicals
Living organisms	Fish, algae, diatoms, and minute animals	Viruses, fungi, bacteria, algae and diatoms	CO_2 O_2			

TABLE VI - 2

SOURCE AND SIGNIFICANCE OF DISSOLVED MINERAL CONSTITUENTS AND PROPERTIES OF WATER

Constituent or property	Source or cause	Significance
Silica (SiO_2)	Dissolved from practically all rocks and soils, commonly less than 30 ppm. High concentrations, as much as 100 ppm, generally occur in highly alkaline waters.	Forms hard scale in pipes and boilers. Carried over in steam of high pressure boilers to form deposits on blades of turbines. Inhibits deterioration of zeolite-type water softeners. It is required for the growth of sponges and diatoms.
Iron (Fe)	Dissolved from practically all rocks and soils. May also be derived from iron pipes, pumps, and other equipment. More than 1 or 2 ppm of soluble iron in surface waters generally indicates acid wastes from mine drainage or other sources.	On exposure to air, iron in groundwater oxidizes to reddish-brown precipitate. More than about 0.3 ppm stains laundry and utensils reddish-brown. Objectionable for food processing, textile processing, beverages, ice manufacture, brewing, and other processes. USPHS (1962) drinking water standards state that iron should not exceed 0.3 ppm. Larger quantities cause unpleasant taste and favor growth of iron bacteria. It lessens the aesthetic value where precipitates form.
Manganese (Mn)	Dissolved from some rocks and soils. Not so common as iron. Large quantities often associated with high iron content and acid waters.	Same objectionable features as iron. USPHS (1962) drinking water standards state that manganese should not exceed 0.05 ppm. Causes dark brown or black stain.
Calcium (Ca) and Magnesium (Mg)	Dissolved from practically all rocks and soils, but especially from limestone, dolomite, and gypsum. Calcium and magnesium are found in large quantities in some brines. Magnesium is present in large quantities in sea water. Contained in some industrial wastes.	Causes most of the hardness and scale-forming properties of water; soap consuming (see Hardness). Waters low in calcium and magnesium desired in electroplating, tanning, dyeing, and in textile manufacturing.

Sodium (Na) and Potassium (K)	Dissolved from practically all rocks and soils. Found also in ancient brines, sea water, industrial wastes and sewage. Contained in some mine water.	Large amounts, in combination with chloride, give a salty taste. Moderate quantities have little effect on the usefulness of water for most purposes. Sodium salts may cause foaming in steam boilers and a high sodium content may limit the use of water for irrigation.
Nitrogen, organic and Ammonia (N)	Sewage, decaying organic matter, legume plants, and ammonia fertilizers. Some industrial waste discharges.	Concentration much greater than the local average, may suggest pollution. NH_3 is toxic to aquatic organisms at low concentrations with high pH values.
Bicarbonate (HCO_3) and Carbonate (CO_3)	Action of carbon dioxide in water on carbonate rocks such as limestone and dolomite. Concentrations in water affected by photosynthetic activity of algae.	Bicarbonate and carbonate produce alkalinity. Bicarbonates of calcium and magnesium decompose in steam boilers and hot water facilities to form scale and release corrosive carbon dioxide gas. In combination with calcium and magnesium they cause carbonate hardness. Used as a CO_2 source by algae in photosynthesis when free CO_2 is exhausted.
Sulfate (SO_4)	Dissolved from rocks and soils containing gypsum, iron sulfides, and other sulfer compounds. Commonly present in mine waters and municipal wastes and in some industrial wastes.	Sulfate in water containing calcium forms hard scale in steam boilers. High concentrations of sulfate in combination with other ions gives a bitter taste to water. Some calcium sulfate is considered beneficial in the brewing process. USPHS (1962) drinking water standards recommend that the sulfate content should not exceed 250 ppm. Combines with Ca and Mg to form permanent hardness.
Chloride (Cl)	Dissolved from rocks and soils. Present in sewage and found in large amounts in ancient brines, sea water and industrial wastes. In some groundwater.	Large amounts in combination with sodium give a salty taste to water. In large quantities increases the corrosiveness of water. USPHS (1962) drinking

Chloride (Cl) cont.		water standards recommend that the chloride content not exceed 250 ppm.
Fluoride (F)	Dissolved in small to minute quantities from most rocks and soils. Added to many waters by fluoridation of municipal supplies. By-product from phosphate fertilizer industry. Also from phosphate fertilizer in land runoff. Mining waste discharges often contain fluoride in association with apatite ore.	Fluoride in drinking water reduces the incidence of tooth decay when the water is consumed during the period of enamel calcification. However, it may cause mottling of the teeth depending on the concentration of fluoride, the age of the child, the amount of water consumed, and the susceptibility of the individual. The maximum concentration of fluoride recommended by the USPHS (1962) varies with the annual average of maximum daily air temperatures and ranges downward from 1.7 ppm for an average maximum daily temperature of 50.0 degrees F to 0.8 ppm for an average maximum daily temperature of 90.5 degrees F. Optimum concentrations for these ranges are from 1.2 to 0.7 ppm.
Nitrite (NO_2)	Generally formed by bacterial action from organic and ammonia nitrogen.	Nitrites quickly oxidize to nitrates and therefore are seldom present in surface waters in significant concentrations. Their presence often indicates pollution.
Nitrate (NO_3)	Decaying organic matter, legume plants, sewage, nitrate fertilizers, and nitrates in soils. Some industrial waste discharges.	Concentration much greater than the local average may suggest pollution. USPHS (1962) drinking water standards suggest a limit of 45 ppm. Waters of high nitrate content have been reported to be the cause of methemoglobinemia (an often fatal disease in infants) and therefore should not be used in infant feeding. Nitrate has been shown to be helpful in reducing the intercrystalline cracking of boiler steel. It encourages the growth of algae and other organisms which may cause odor

Nitrate (NO_3)cont.		problems in water supplies and reduce the aesthetic value of streams and reservoirs.
Phosphates (PO_4)	Dissolved from many rocks and soils. The orthophosphate form is the only form derived from natural sources. Orthophosphate and other forms come from fertilizers, detergents, domestic and industrial wastes. Phosphate is used in some water treatment plants for softening.	Concentrations generally found in water are not toxic to man, animals or fish. Phosphates stimulate the growth of algae which may cause odor problems in water supplies and reduce the aesthetic value of streams and reservoirs.
Detergents (ABS)	Chiefly from sewage. The active ingredient in most anionic synthetic detergents is the group of alkyl benzene sulfonates, generally termed ABS. ABS resists bacterial degradation and therefore persists in sewage and streams without appreciable decomposition from either treatment processes or natural purification.	Produces foaming, turbidity, taste and odor problems. May interfere with coagulation and floc formation in municipal treatment plants. USPHS (1962) drinking water standards suggest a limit of 0.5 ppm, based more on undesirable taste and foaming than on toxicological consideration.
Dissolved solids	Chiefly mineral constituents dissolved from rocks and soils.	USPHS (1962) drinking water standards recommend that the dissolved solids should not exceed 500 ppm. However, 1,000 ppm is permitted under certain circumstances. Waters containing more than 1,000 ppm of dissolved solids are unsuitable for many purposes.
Hardness as $CaCo_3$	In most waters nearly all the hardness is due to calcium and magnesium. All of the metallic cations other than the alkali metals also cause hardness.	Consumes soap before a lather will form. Deposits soap curd on bathtubs. Hard water forms scale in boilers, water heaters and pipes. Hardness equivalent to the bicarbonate and carbonate is called carbonate hardness. Any hardness in excess of this is called non-carbonate hardness. Waters of hardness up to 60 ppm are considered soft; 61 to 120 ppm, moderately hard; 121 to 180 ppm, hard; more than 180 ppm, very hard.

Specific conductance (Micromhos at 25 degrees C)	Mineral content of the water. Free hydrogen or hydroxyl ions in water.	Indicates degree of mineralization. Specific conductance is a measure of the capacity of the water to conduct an electric current. It varies with the concentration and degree of ionization and temperature.
Hydrogen ion concentration (pH)	Acids, acid-generating salts and free carbon dioxide lower the pH. Carbonates, bicarbonates, hydroxides, phoxphates, silicates, and borates raise the pH. Algal productivity can have a significant effect on pH in streams and reservoirs.	A pH of 7.0 indicates neutrality of a solution. Values higher than 7.0 denote increasing alkalinity; values lower than 7.0 denote increasing acidity. pH is a measure of the activity of hydrogen ions. Corrosiveness of water generally increases with decreasing pH. However, excessively alkaline waters may also attack metals. Toxicity of NH_3 to aquatic life is largely dependent of pH. Affects solubility of metals.
Color	Yellow-to-brown color of some waters usually is caused by organic matter extracted from leaves, roots, and other organic substances. Color in water also results from industrial wastes, sewage and dissolved minerals.	Water for domestic and some industrial uses should be free from perceptible color. Color in water is objectionable in food and beverage processing and many manufacturing processes. It is also objectionable asthetically and can have effects on biological productivity.
Turbidity	Attributable to suspended and colloidal matter which disturbs clearness and diminishes the penetration of light. The suspended matter may contain silica, zinc, iron and manganese compounds, clay or silt, sawdust, fibers or other material. These materials may enter the water as a result of natural processes such as erosion or as a result of the addition of domestic sewage or industrial wastes and mining operations. Planktonic algae can cause turbidity.	The 1962 USPHS drinking water standards specify that turbidity shall not exceed 5 units. Turbidity is undesirable in waters for laundries, ice making, bottled beverages, textiles, steam boilers and turbine operations and other industrial processes. It is objectionable in streams and lakes asthetically and can cause reduction in the productivity of streams and lakes.

Temperature	Climatic conditions, use of water as a cooling agent, municipal and industrial wastes. Spring and groundwater influence, reservoir discharges and mine pumpage.	Affects usefulness of water for many purposes. Most users desire water of uniformly low temperature. Seasonal fluctuations in temperature of surface waters are comparatively large depending on the volume of water. Shallow wells show some seasonal fluctuations in water temperature, which is near the mean annual air temperature of the area. In deep wells the water temperature generally increases 1 degree F for each 60 to 80 feet of depth. Temperature affects the biota of a stream or lake. Permanent changes such as discharge from a deep reservoir can change a stream from a warm water fishery to a cold water fishery. A rapid change can cause fish kills.
Dissolved Oxygen (D.O.)	Introduced from the atmosphere and through photosynthetic activity by algae. Reduced by biological respiration and waste discharges containing reducing agents.	Required for the maintenance of aerobic conditions in a stream or lake. It is necessary that about 5 mg/l be present for a healthy fishery to exist. Saturation point is dependent upon water temperature and pressure.
Heavy Metals	Leached from soils in trace amounts. They are found in waste discharges from industries such as metal plating plants, oil industries, mining and related industry. Municipal waste effluents often contain significant concentrations.	Many heavy metals must be limited for safe water supplies. They are toxic in very low concentrations to the aquatic environment. They are necessary in trace amounts for living organisms.

METHOD OF STUDY

Due to the variation in size of the basins and tributaries within the study area and also to the variation in characteristics of each, the study area was divided as follows:

1. James River and its tributaries
2. Elk River and its tributaries plus Honey Creek and Lost Creek (Missouri portion)
3. Spring River and its tributaries (Missouri portion)
4. Turkey Creek and Shoal Creek (Missouri portion)
5. Center Creek (Missouri portion)

OBSERVATIONS AND ANALYSES IN THE JAMES RIVER BASIN

Physical Features

Streamflow in the upper James River Basin is of a very complicated nature. The area in and around Springfield has many sinkhole areas and several major and minor springs. Studies have shown Wilson Creek to have a complex network of gaining and losing water flows. Sinks near and downstream from the Springfield sewage treatment plant have been shown to be connected, in part, to Rader Spring, several miles downstream from the treatment plant. Extreme flow fluctuations occur in Wilson Creek during low flow periods. During the summer sampling period at Jw-1 nearly all of the flow had gone underground. This included principally the 10-20 cfs discharge from the sewage treatment plant. It should be noted that during low flow periods the sewage treatment plant discharge provides practically all the flow in Wilson Creek. Under such conditions Wilson Creek provides greater than half of the flow in the James River below their confluence.

Surface water flows in the other tributaries of the James River Basin are maintained by groundwater inflow during seasonal dry periods. Several springs of significant size are located in each of these tributaries.

Water temperature is affected by groundwater in the tributaries of the James River Basin to varying degrees. The extremes of water temperature as caused by ambient air temperature were avoided in areas near spring or groundwater inflow.

Turbidity in the James River Basin, as caused by stormwater, is of short duration. The streams in the area rise and fall quickly during and after heavy rainfall, and the colloidal material which enters during runoff does not persist to any extent. Turbidity from causes other than land runoff were basically

confined to Wilson Creek where effluent from the Springfield Southwest Sewage Treatment Plant accounts for most of the flow during normal flow periods.

Color shows a relationship similar to turbidity during normal stream flows. The only color of major significance was noted in Wilson Creek at stations Jw-1 and Jw-2. Color from Wilson Creek was reflected at J-5 in the James River.

The specific conductance of unaffected waters in the James River Basin is generally 250-300 micromhos. This concentration is due largely to minerals contained in groundwater and those which are dissolved from rocks and soils from and along the stream bed. The relatively high conductance found in Wilson Creek below the Springfield Southwest Sewage Treatment Plant is found to affect the conductance at James River stations below the Wilson Creek confluence. J-8, the furthest downstream station, normally had conductance readings averaging 350 micromhos. The high conductance found at these stations was chiefly from chlorides and sulfates found in the sewage treatment plant discharge from Wilson Creek.

Water Chemistry

Dissolved oxygen concentrations in the James River Basin were most notably affected in Wilson and Finley Creeks which receive significant waste loads. Depletion of oxygen occurred during low flow periods in the summer and fall sampling surveys. The volume of wastes entering Wilson Creek from the Southwest Sewage Treatment Plant at Springfield was too large to be assimilated. The problem was compounded by a portion of the discharge from the plant going underground near the discharge point and resurfacing, in part, at Rader Spring. No photosynthetic activity was present during the underground period to maintain oxygen levels required in the organic oxidation process. Consequently, the discharge from Rader Spring was commonly found to be septic or nearly so. Since the time of the survey, the point of discharge from the sewage treatment plant at Springfield has been changed to below this losing section thus improving the water quality of Rader Spring.

During low flow periods in the James River Basin, Wilson Creek has a much larger flow than does the James River mainstem above their confluence. At such times, the oxygen below their confluence is depressed for a considerable distance downstream.

During the survey, the dissolved oxygen in a section of Finley Creek was depressed by an inadequately treated waste discharge from a cheese processing plant in Ozark, Missouri. Proper facilities are now in operation, and the oxygen problem has been resolved.

The pH of all the sampling stations in the James River Basin was influenced by photosynthetic activity. No highly alkaline or acidic wastes were routinely discharged which would affect the pH. Certain waste discharges did, however, ultimately affect the pH in that the rate of photosynthetic activity was affected.

This was noted in Wilson Creek where the pH did not reach 8.0 during any sampling period. The amount of wastes in the creek were at a level where the oxygen demand could not be met and more CO_2 was produced than could be used. Thus bicarbonates were not used as a CO_2 source which would have raised the pH above 8.0. As these wastes were diluted and lessened as at stations J-7 and J-8, the heavy growth of algae which had become established required large quantities of CO_2 from the organic oxidation process. After the free CO_2 became exhausted, the bicarbonates were used as a further CO_2 source. As a result, the pH at these stations was commonly above 8.0.

This phenomenon occurred in streams similarly influenced by organic wastes, the concentration of organic material being an important regulating factor. Finley Creek, which received cheese processing wastes showed pH variations of a similar nature during the survey.

The hardness of the water in the James River Basin is influenced greatly by groundwater. The relative calcium and magnesium concentrations are very similar to those encountered in groundwater supplies within the basin. Waste discharges are not believed to significantly vary the total hardness of the James River and its tributaries.

The concentration of the various forms of nitrogen in Wilson Creek was found to be affected by the waste discharge from Springfield. Ammonia was found in high concentrations at Jw-1 and Jw-2, as well as in the Rader Spring discharge. At downstream stations on the James River, the nitrogen was more commonly found in the form of nitrates.

A large concentration of phosphates enter Wilson Creek from the Springfield treatment plant discharge. During low flow periods in Wilson Creek, values as high as 29 mg/l were observed. This remained in significant quantities downstream in the James River and is partly responsible for heavy algal growths noted at various times. Phosphates were not found in significant quantities elsewhere in the basin.

Detergents were found only in Wilson Creek at Jw-1, Jw-2, and in Rader Spring.

The parameters of iron and manganese were not found in abnormal quantities. Normally these are associated with waters high in acidity.

Sulfates were observed in higher than normal concentrations in Wilson Creek. Additions from the various components of the domestic and industrial wastes of the Springfield sewage treatment plant discharge are thought to be the primary source of these sulfates.

The parameters of sodium and potassium were noted in high concentrations in all Wilson Creek stations and in significant concentrations at the James River stations downstream from Wilson Creek. Chlorides, which were associated with sodium and potassium were present in similar proportions. A high concentration of sodium, potassium, and chlorides was found during the 1964 summer survey at J-4 upstream from the Wilson Creek confluence and not at J-3, which was several miles further upstream. The source of these concentrations was not found.

Fluorides were not consistently high at any station. Occasional concentrations of 1.0 - 2.0 mg/l, presumably associated with the waste discharge from Springfield, were found in Wilson Creek.

Bacterial Quality

In all cases in the James River and its tributaries, the bacteria were chiefly of human origin. Where a significant number of bacteria was present, the ratio of coliform to fecal streptococcus organisms was greater than one, which would generally indicate human wastes.

The major contribution of bacteria in the basin was the discharge from the Springfield Southwest Sewage Treatment Plant entering Wilson Creek. High

concentration stemming from this source extend downstream into the James River at J-5. Although the major portion of these organisms had died off at this point, enough remained to indicate the definite presence of human wastes.

Pearson Creek and Sequiota Creek in the headwater areas of the James River had concentrations of coliform bacteria several times higher than could be expected from natural sources. Septic tank drainage from this moderately populated, unsewered area, is the suspected source.

Waste discharges to Finley Creek near Ozark were the source of significant bacteria counts during several surveys. Municipal waste discharges from the City of Ozark and a waste discharge from a cheese processing plant provided a source and sustenance for these organisms.

During one low flow season, a slight increase in coliform numbers was evidenced in Flat Creek below the City of Cassville. This increase, although showing evidence of human waste influence, was relatively slight.

During the survey, the City of Galena had a raw sewage discharge to the James River between stations J-7 and J-8. A large dilution factor was present, and no significant increase in numbers occurred between these two stations.

No significant livestock populations were noted in the basin to influence bacteria concentrations. The only time animal wastes were an influence on bacterial water quality was during high stream flows.

OBSERVATIONS AND ANALYSES IN THE ELK RIVER AND ITS TRIBUTARIES PLUS HONEY AND LOST CREEKS

Physical Features

Data collected during the survey show little variation in water quality from station to station in the Elk River Basin. The physical parameters generally show water quality as affected by the natural elements only, such as dissolved minerals, turbidity from runoff, etc.

Groundwater influence prevents extreme surface water temperature variation throughout the seasons in some stream stretches. Although there are no major springs in the Elk River Basin, considerable groundwater entrance exists to

maintain flows during prolonged dry weather conditions.

Specific conductance of the surface waters under natural conditions ranged between 200 and 250 micromhos. Little or no variation of this range was found at any of the sampling stations in the Elk River Basin.

Turbidity and color analyses were consistent in that no abnormalities appeared at any station. Significant turbidity was noted only during high water conditions, and color readings were within ranges normally recorded during oxidation of organic material associated with leaves, roots, etc.

Water Chemistry

No significant variation in the chemical parameters measured were observed at any of the sampling stations in the Elk River Basin and its tributaries. For the slight variations which did occur, it would be difficult to determine the causative agent. Although several significant waste discharges existed during the survey, the dilution ratio created by the receiving waters greatly diminished any noticeable effect.

Since the time the Stream Survey was conducted, changes have occurred in wastes discharged to the Elk River Basin, primarily an increase in volume. It is possible that these discharges are now creating a noticeable effect on water quality at the stations sampled during the survey.

Bacterial Quality

Concentrations of coliform and fecal streptococcus bacteria were low at all stations in this study area with little exception. At only one point did either type of bacteria exceed 200/100 ml. This was at Ei-2, on Indian Creek, which received the wastes from the City of Anderson along with some industrial wastes. Coliform bacteria there were found at a concentration of 800/100 ml. during the summer survey.

Although the Elk River Basin receives waste discharges from several sources, some of which contain significant numbers of bacteria, the large dilution factor produced by the receiving streams created low numbers of bacteria at most sampling stations.

OBSERVATIONS AND ANALYSES IN THE SPRING RIVER AND ITS TRIBUTARIES

Physical Features

Two individual types of streams are involved in this study area. The mainstem of the Spring River which heads in the vicinity of Aurora is characteristically an Ozark stream while the North Fork of the Spring River is a prairie stream. These differences are reflected in the various physical parameters measured during the survey.

Stream flows in the North Fork are not sustained by groundwater inflow during the dry seasons. The North Fork is commonly found to have no flow at some period during the year above Lamar. The flow below Lamar during such periods is sustained only by the City's treatment facility discharge.

Water temperature varies between the mainstem and the North Fork. Water in the North Fork commonly freezes in the winter and approaches ambient air temperatures in the summer. Headwaters of the mainstem avoid these extremes due to the groundwater influence. Springs in the area of Aurora and Mount Vernon have substantial discharges which influence surface water temperatures.

The specific conductance under natural conditions is affected by groundwater and runoff. In prairie streams, such as the North Fork, the conductance typically was in the range of 150-200 micromhos. These relatively low values show the lack of groundwater contribution to surface water flows. The influence of the lagoon discharge at Lamar adds to this value, however, especially during low flow periods. The specific conductance of the mainstem is somewhat higher, due primarily to the dissolved minerals contained in the groundwater which it receives.

Turbidity and color are generally greater in the North Fork. The suspended clay particles are persistent for a considerable amount of time following the entrance of runoff from heavy rains. Also during low flow periods, planktonic algae contained in the Lamar lagoon discharge were found to increase the turbidity. Colloidal material is precipitated rapidly in the headwaters of the mainstem, and the inflow of clear groundwater further assures little turbidity and color.

Waste discharges which increased the turbidity in the Spring River mainstem included those from two marble cutting operations and a municipal water works.

Approximately three stream miles below Carthage were affected by these turbid discharges. Settling basins and proper disposal facilities have since been installed by these concerns.

Water Chemistry

Dissolved oxygen was most notably affected in Williams Creek below the City of Mount Vernon and in the North Fork of the Spring River below the City of Lamar. During low flow periods at these points, treated municipal wastes contribute nearly 100% of the total streamflow. The organic material remaining in these discharges depress the oxygen levels significantly as shown in Appendix D.

In most cases, pH and alkalinity were influenced chiefly by varying photosynthetic activity. The pH normally ranged from 7.0 - 8.5 with total alkalinity values near 150 mg/l. The one exception to this occurred in the North Fork of the Spring River, where water quality was influenced by an area of coal mining and its associated runoff. Runoff from this area was thought to lower the alkalinity and pH values during high flow periods.

Total hardness is generally in the range of 130-150 mg/l in this study area. Runoff low in dissolved minerals in the North Fork accounts for the lower total hardness values recorded there.

The various forms of nitrogen were fairly consistent throughout this study area. Nitrates were recorded at 2.0 mg/l or slightly more in the extreme upper end of the Spring River at stations S-1, S-2, S-3. This slight increase may have been attributable to nitrates contained in waste discharges emanating in that area, since streamflows during dry weather were composed mostly of waste discharges.

The highest concentration of iron was recorded at Snf-3 during high flows. This would further lend to the idea of water quality influence from the coal bearing strata in that area.

Sulfates were also found to be the highest in the North Fork drainage area. This also may be attributed, at least in part, by slightly acid runoff waters from this area.

No appreciable differences in sodium, potassium, and chloride were observed among any of the streams in this study area.

Bacterial Quality

In the headwaters of the Spring River, an increase in coliform numbers occurred at S-3 during the winter and spring surveys. These were the only seasons in which any flow entered the Spring River above S-3 from the small stream receiving the treated wastes from the City of Aurora.

Fairly large counts were noted in Williams Creek during the survey. This is from the waste discharge from the City of Mt. Vernon, which provides most or all of the total stream flow in Williams Creek during low flow periods. These counts dwindled quickly upon entering the Spring River, as concentrations were normal at S-4.

Counts were increased considerably at station S-6 by the Carthage sewage treatment plant discharge. Coliform counts reached 27,000/100 ml. during the survey and fecal streptococcus counts exceeded 1000/100 ml. during one season. These counts were reduced downstream at S-7 to only a slight concentration.

Bacteria of numerical significance in the North Fork of the Spring River were found only during high stream flows, which would indicate the source to be chiefly from animal wastes contained in runoff.

OBSERVATIONS AND ANALYSES IN CENTER CREEK

Physical Features

The flow in Center Creek is well sustained by groundwater along its course. Clarkson Spring, located in the Center Creek headwaters in Lawrence County, represents the largest spring discharge to the system. The only major waste discharge which influences the flow in Center Creek is the discharge from the Grove Creek industrial complex. The flow from this complex may contribute 5-10% of the total flow in Center Creek during some periods.

Water temperatures in Center Creek are influenced by seasonal climatic conditions and groundwater. The temperature in the upper reaches in particular is stabilized somewhat throughout the year by groundwater entrance. Waste discharges are not believed to affect the water temperature in Center Creek.

Specific conductance in Center Creek is influenced by three major sources. Under natural conditions groundwater maintains the specific conductance at approximately 250 micromhos. This reading is common in the upper regions of Center Creek. As Grove Creek enters Center Creek it carries acidic wastes and some dissolved minerals at times which substantially increase the specific conductance. These particular wastes are discharged from industries located along Grove Creek. As Center Creek progresses from Sc-4, just below the Center-Grove Creek confluence, to Sc-8, near its mouth, the specific conductance increases. This has been shown to result from the seepage of mine water containing a high mineral content into Center Creek at various points between these two stations.

With the exception of periods immediately following heavy runoff, turbidity in Center Creek is very slight. Turbidity was found to be affected slightly by waste discharges in two instances. A gravel washing operation in the Carterville-Webb City area with inadequate settling facilities was found to cause a small increase during the survey. The turbidity below the entrance of Grove Creek into Center Creek was found to decrease at times. This was due to flocculating agents in the waste discharge from an industry along Grove Creek.

Water Chemistry

The chemical parameters in Center Creek were probably more affected by waste discharges than any other study area in the Spring River Basin with the possible exception of Turkey Creek.

The dissolved oxygen, pH, and alkalinity were altered below the Center-Grove Creek confluence. Significant concentrations of ammonia in industrial wastes discharged to Grove Creek were expected to cause the oxygen depression as it was oxidized in Center Creek. As the discharge to Grove Creek was low in pH, the pH and alkalinity in Center Creek were reduced.

The total hardness of the water in Center Creek was increased below Grove Creek initially by waste discharges of the industrial complex and then from mine water seepage into Center Creek further downstream from the Grove Creek - Center Creek confluence.

The high concentrations of ammonia, nitrates, and nitrites at Sc-4 and points below resulted from large amounts of ammonia discharged to Grove Creek from the industrial complex.

Phosphates were also increased at these points, as one of the industries in the complex was a producer of phosphate fertilizers.

Detergent concentrations were insignificant at all sample points in Center Creek.

At no point in the Stream Survey were the parameters of iron and manganese found in excess of 1.0 mg/l in Center Creek. Although the pH in Grove Creek was quite low, no available source of these metals was present to be taken into solution.

Data on zinc concentrations, while not included in the tabulation of data in Appendix D, has been obtained on various surveys of Center Creek. Significant concentrations of zinc begin to appear in Center Creek below the confluence of Grove Creek. This initial occurrence may be attributed to cooling water discharges from industries along Grove Creek who use mine water for this purpose. Further concentrations of zinc at downstream Center Creek stations have been shown to stem from groundwater seepage from old mines and mining areas plus cooling and wash water form several industries using mine water for these purposes.

Sulfates were found abundant at Sc-4 and then increased after that point. The initial concentration found at Sc-4 was contributed by industrial activity along Grove Creek. A portion of the sulfates contributed by industry at this point is found in the cooling water used which is taken from abandoned mines in that area. Additions to the sulfate concentrations below Sc-4 were made by groundwater seepage from old zinc mining areas.

Silica and fluorides were found at highest levels below the Grove Creek confluence in Center Creek. The ore which was processed by an industry along Grove Creek contained a considerable amount of fluorides. The action of acids on this ore during the process dissolved the fluorides, creating a solution capable of removing silica from rocks in the watercourse which would not be affected otherwise.

A slight increase in sodium and chloride was noted in Center Creek below Grove Creek. This may have been contributed by a treated domestic waste discharge serving the industrial complex or possibly from some phase of production within the industries.

Several small municipalities discharged to Center Creek near the most downstream stations. Only slight alterations, if any, in the chemical quality were observed to have been caused by these discharges.

The chemical characteristics of Center Creek above the Grove Creek confluence were typical of streams in the area receiving base flow from groundwater sources.

Bacterial Quality

Coliform and fecal streptococcus counts were moderate to low at all stations in Center Creek. The major discharges entering Center Creek were from industries and typically contained a very small amount of bacteria.

The City of Sarcoxie may have influenced samples at Sc-2 and Sc-3. However, most of the organisms found were believed to originate from swimming activities in the summer months. Counts at these stations were quite low during the other seasons.

Carterville, which discharged raw sewage to a small tributary of Center Creek, showed no real effect on the bacterial water quality of Center Creek. Other cities in this area discharged treated wastes to Center Creek with little noticeable effect. This apparent limitation of bacteria numbers is thought to be caused, at least in part, by heavy metal concentrations in Center Creek at these points.

OBSERVATIONS AND ANALYSES IN TURKEY AND SHOAL CREEKS

Physical Features

Flow in Turkey Creek is sustained by waste discharges during dry seasons. Although some groundwater influence exists in the Turkey Creek watershed, it is not significant to maintain base flows. Conversely, streamflow is well maintained in Shoal Creek by groundwater. Springs west of Exeter and Capps Creek are quite significant and provide a sizeable contribution to streamflow in Shoal Creek.

Specific conductance of waters in Turkey and Shoal Creeks, in their natural condition, range from 200-250 micromhos. Waste discharges entering Turkey Creek

substantially increase the specific conductance as shown by data collected at St-9. Only slight fluctuations, which could originate from waste discharges, can be noted at stations in the Shoal Creek watershed. The streamflow was great enough at Ss-10 that the waste discharge from Joplin's Shoal Creek treatment plant provided little or no effect on water quality.

Turbidity readings were very low in Shoal and Turkey Creeks at the points they were sampled. Shoal Creek is normally a very clear stream as would be expected of a stream receiving considerable groundwater. It is suspected that the turbidity of Turkey Creek was increased in areas below the entrance of waste discharges but was not shown at the single sampling station visited during the stream survey.

Color analyses were not made at the Turkey Creek station during the survey. Color, however, should vary in similar proportions as the turbidity in regard to the influence of most waste discharges. Color in Shoal Creek was very slight during each survey.

Water Chemistry

An analysis of all the chemical parameters was not made on Turkey Creek and Shoal Creek. A comprehensive water quality study was made of Turkey and Shoal Creeks in 1958 and 1959, and samples were collected during the Stream Survey only to note any changes which may have occurred. Parameters which were not measured during the survey include nitrate-nitrogen, detergents as ABS, iron, manganese, sulfates, silica, sodium, potassium, chloride, and fluoride. The lower Shoal Creek station, Ss-10, was an exception in that a complete set of analyses was performed of samples collected at that point during each season.

No significant variations were found in the water quality of Shoal and Turkey Creeks at most of the Stream Survey sampling stations. Some variations were noted in Shoal Creek below the City of Neosho in the water quality study of 1958-1959. These variations were all typical of those normally created by municipal wastes.

The dissolved oxygen was consistently below saturation at St-9. Waste discharges, primarily from a sewage treatment plant at Joplin, contained quantities of oxygen-demanding materials large enough to depress the oxygen to these lower levels.

The pH at St-9 indicated a small amount of photosynthetic activity. All the free CO_2 produced by organic oxidation was not utilized, therefore, the pH was maintained below 8.0.

Total alkalinity and total hardness were increased slightly by the various waste discharges from Joplin. Total alkalinity above any waste sources in Turkey Creek were commonly 100 mg/l or less, whereas at St-9 a reading of 150-200 mg/l occurred frequently.

Ammonia levels in Turkey Creek at St-9 were quite variable during the Stream Survey. Values as low as 0.25 mg/l and as high as 5.0 mg/l were recorded. The variable rate of ammonia oxidation under different conditions in the Creek at this point and the somewhat variable waste discharges would be an influence on these readings. Also, the dilution ratios at various streamflows influence these concentrations.

Nitrate-nitrogen was recorded at a concentration of nearly 7.0 mg/l in Shoal Creek during one season while lower readings were noted in other seasons. The many and varied factors influencing the oxidation of ammonia are thought to be partly responsible for this fluctuation. A major contributor to the nitrates found at this point is the discharge from Joplin's Shoal Creek sewage treatment plant.

Bacterial Quality

The fact that Turkey Creek receives the majority of the wastewater from the City of Joplin is reflected in the bacteria concentrations found at station St-9. During a major portion of the year Turkey Creek is sustained by waste discharges. Little or no dilution is provided for these wastes. More detailed bacteriological data concerning Turkey and Shoal Creeks may be found in an earlier study of that area, "Shoal-Turkey Creek, A Water Quality Study, 1958-1959".

Very little can be detected from the data obtained during the Stream Survey. An increase in coliform bacteria occurred at Ss-10 which was attributed to the waste discharge from the City of Joplin. The water quality study of 1958-1959 depicted livestock as contributing to bacteria concentrations in the headwaters near Wheaton and in Capps Creek. The waste discharge from the City of Monett

was principally responsible for high counts in Clear Creek. Shoal Creek below Neosho was found to be affected downstream for a considerable distance from the City's treatment plant discharge. Swimming was thought to have elevated counts at several points along Shoal Creek and several of its tributaries.

The count at Ss-10 was considered lower than could be expected as a sizeable sewage treatment plant discharge occurred upstream from this point. Grand Falls was thought to be partly responsible for this reduction as it increased the detention time between the treatment plant discharge and the sample point, thus allowing a greater die-off.

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Missouri Geological Survey and Water Resources
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APPENDIX C

JAMES
ELK, SPRING

WATER QUALITY REPORT

BIOLOGICAL DATA
1973

missouri
clean water commission
p. o. box 154
jefferson city, missouri 65101

11010002

WATER QUALITY

of

JAMES, ELK, AND SPRING RIVER BASINS

January, 1974

APPENDIX C

BIOLOGICAL DATA

Missouri Geological Survey and Water Resources
Missouri Department of Conservation
Missouri Clean Water Commission

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APPENDIX C
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APPENDIX C

The purpose of the following data sheets listing macroinvertebrates collected within the Elk, James, and Spring River Basin is to provide data that may be used as a base for future studies, and to document the discussion in the text.

BENTHOS ANALYSIS

STREAM Little Sugar Creek STATION Els-1 DATE 8-17-64

NUMBER OF ORGANISMS 265 TAXA 31 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaetes	22

MOLLUSCA

Gastropoda

Goniobasis sp.	30
Ferrissia sp.	1
Physa sp.	1
Planorbidae	5

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Immature	5

INSECTA
PLECOPTERA

Neoperla clymene	2
Acroneuria arida	15

EPHEMEROPTERA

Ephemera sp.	2
Stenonema tripunctatum	2
S. nepotellum	20
S. (Gp 3 unk.)	3
Heptagenia maculipennis	5
Baetis sp.	4
Tricorythodes sp.	6
Caenis sp.	1
Choroterpes sp.	1
Isonychia sp.	2

ODONATA

Ophiogomphus	2
Argia sp.	2
Gomphidae (im.)	2

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	8

TRICOPTERA

Caborius cases	5
Cheumatopsyche sp.	2
Helicopsyche sp.	1

LEPIDOPTERA

COLEOPTERA

Ectoparia sp.	2
Stenelmis sp.	6
Psephenus sp.	90

DIPTERA

Atherix variegata	10
Eriocera sp.	
Tendipedidae	8

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Little Sugar Creek STATION Els-1 DATE 11-1-64

NUMBER OF ORGANISMS 939 TAXA 32 DIVERSITY

PLATYHELMINTHES

Planaria	8

ANNELIDA

Oligochaeta	40
Hirudinea	3

MOLLUSCA

Gastropoda

Goniobasis sp.	18
Ferrissia sp.	15
Amnicola sp.	1

Pelecypoda

Sphaerium sp.	30

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

Neoperla clymene	50
Neophasgonophora capitata	16

EPHEMEROPTERA

Ephemera varia	7
Isonychia sp	90
Baetis sp	125
Caenis sp	3
Stenonema nepotellum	18
S. interpunctatum	30
S. bipunctatum	70

ODONATA

Argia sp.	7
Gomphidae (im.)	4

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	11

TRICOPTERA

Helicopsyche sp.	4
Caborius sp.	30
Dolophilus sp.	2
Chimarra obscura	7
Cheumatopsyche sp.	75
Empty cases	8

LEPIDOPTERA

COLEOPTERA

Ectoparia sp. (L)	4
Psephenus sp. (L)	125
Stenelmis sp. (L)	20
S. sp. (A)	5
Optioservus sp. (L)	3

DIPTERA

Chrysops sp.	1
Limonia sp.	4
Simulium sp.	65
Tendipedidae	40

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Little Sugar Cr. STATION Els-1 DATE 2-10-65

NUMBER OF ORGANISMS 951 TAXA 39 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	20

MOLLUSCA

Gastropoda

Goniobasis sp.	12
Ferrissia sp.	7

Pelecypoda

Sphaerium sp.	18

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

Perlinella drymo	15
Isoperla clio	45
Isoperla richardsoni	20
Neoperla clymene	8
Branchyptera fasciata	2
Neophasgonophora capitata	7

EPHEMEROPTERA

Isonychia sp.	50
Leptophlebia sp.	4
Choroterpes sp.	3
Ephemerella invaria	225
Ephemera guttalata	2
Pseudocloeon sp.	60
Stenonema ares	7
Stenonema nepotellum	9

ODONATA

Chromagrion sp.	1
Agrionidae	1
Gomphidae	2

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	7
Sialas sp.	1

TRICOPTERA

Chimarra obscura	1
Agapetus sp.	10
Cheumatopsyche sp.	155
Oecetis eddlestoni	6
Helicopsyche sp.	3

LEPIDOPTERA

COLEOPTERA

Ectoparia sp. (L)	15
Psephenus sp. (L)	30
Dubiraphia sp. (L)	1
Optioservus sp. (L)	5
Stenelmis sp. (L)	12

DIPTERA

Atherix sp.	20
Chrysops sp.	7
Hexatoma sp.	3
Simulium sp.	30
Tendipedidae	125

MISCELLANEOUS

Nemato morpha	2

REMARKS:

BENTHOS ANALYSIS

STREAM Little Sugar Cr. STATION Els-1 DATE 5-4-65

NUMBER OF ORGANISMS 570 TAXA 29 DIVERSITY

PLATYHELMINTHES

Planaria	4

ANNELIDA

Oligochaeta	7

MOLLUSCA

Gastropoda

Goniobasis sp.	5

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes luteus	1

INSECTA

PLECOPTERA

Neophasganophora capitata	60
Neoperla clymene	30
Allocapnia sp.	4

EPHEMEROPTERA

Baetis sp.	40
Ephemerella bicolor	45
E. invaria	30
Stenonema ares	40
S. nepotellum	70
S. interpunctatum	25
Paraleptophlebia praepidita	7
Ephemera simulans	2
Isonychia sp.	17
Heptagenia sp.	23
Rhithrogenia sp.	3

ODONATA

Gomphidae	3

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	4

TRICOPTERA

Cheumatopsyche sp.	40
Chimarra obscura	2
Hydropsyche sp.	4
Neophylax sp.	1

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	55
Stenelmis sp. (L)	6
S. sp. (A)	24
Optioservus sp. (L)	3

DIPTERA

Tendipedidae	15

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Big Sugar STATION Ebs-1 DATE 8-18-64

NUMBER OF ORGANISMS 100 TAXA 21 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	8

MOLLUSCA

Gastropoda

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes (im.)	1

INSECTA

PLECOPTERA

Neoperla clymene	2

EPHEMEROPTERA

Ephemera sp.	1
Caenis sp.	1
Isonychia sp.	7
Tricorythodes sp.	5
Centroptilum sp.	1
Choroterpes sp.	2
Baetis sp.	1
Stenonema nepotellum	7
S. (near frontalis)	6
S. (Gp 3 Unk.)	5

ODONATA

Argia sp.	1

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	10

TRICOPTERA

Helicopsyche sp.	1
Cheumatopsyche sp.	6
Empty cases	

LEPIDOPTERA

COLEOPTERA

DIPTERA

Eriocera sp.	1
Tipulidae	1
Tendipedidae	3

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Big Sugar Creek STATION Ebs-1 DATE 11-1-64

NUMBER OF ORGANISMS 343 TAXA 29 DIVERSITY

PLATYHELMINTHES

Planaria	5

ANNELIDA

Oligochaeta	6

MOLLUSCA

Gastropoda

Goniobasis sp.	30
Physa sp.	5
Ferrissia sp.	14

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes luteus	4

INSECTA

PLECOPTERA

Neoperla clymene	25
Neophasgonophora capitata	18

EPHEMEROPTERA

Baetis sp.	50
Isonychia sp.	17
Ephemera bigutatta	4
Potomanthus sp.	2
Stenenoma nepotellum	25
S. interpunctatum	15
S. bipunctatum	12

ODONATA

Argia sp.	1
Gomphidae (im.)	1

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	12

TRICOPTERA

Helicopsyche sp.	2
Hydropsyche bifida	4
Chimarra obscura	2
Cheumatopsyche sp.	21
Empty cases	2

LEPIDOPTERA

COLEOPTERA

Ectoparia sp. (L)	2
Optioservus sp. (L)	3
Stenelmis sp. (L)	9
S. sp. (A)	4
Psephenus sp. (L)	25

DIPTERA

Hexatoma sp.	4
Silulium sp.	12
Tendipedidae	7

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Big Sugar Cr. STATION Ebs-1 DATE 2-9-65

NUMBER OF ORGANISMS 1510 TAXA 37 DIVERSITY

PLATYHELMINTHES

Planaria	25

ANNELIDA

Oligochaeta	10

MOLLUSCA

Gastropoda

Goniobasis sp.	20
Polygyridae sp.	1
Ferrissia sp.	18

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

~~Gammarus sp.~~	1

Isopoda

Decapoda

Orconectes sp.	3

INSECTA

PLECOPTERA

Branchyptera fasciata	25
Isoperla duplicata	17
Neophasgonophora sp.	35
Isoperla sp.	40
Neoperla clymene	16

EPHEMEROPTERA

Pseudocloeon sp.	60
Ephemerella walkeri	175
E. invaria	55
Stenonema tripunctatum	50
S. nepotellum	30
S. bipunctatum	15
Isonychia sp.	40

ODONATA

Gomphidae	2

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	17

TRICOPTERA

Cheumatopsyche sp.	300
Chimarra obscura	10
Hydropsyche bifida	20
Helicopsyche sp.	4
Caborius sp.	10
Glossosoma sp.	3

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	60
Ectoparia sp. (L)	10
Optioservus sp. (L)	4
Stenelmis sp. (L)	25
Stenelmis sp. (A)	1
Helichus sp. (L)	1

DIPTERA

Tendipedidae	350
Tabanus sp.	2
Chrysops sp.	9
Eriocera sp.	4
Simulium sp.	20
Hemerodromia sp.	2

MISCELLANEOUS

Acari	20

REMARKS:

BENTHOS ANALYSIS

STREAM Big Sugar Cr. STATION Ebs-1 DATE 5-4-65

NUMBER OF ORGANISMS 797 TAXA 42 DIVERSITY

PLATYHELMINTHES	
Planaria	14
ANNELIDA	
Oligochaeta	30
MOLLUSCA	
Gastropoda	
Ferrissia sp.	30
Goniobasis sp.	21
Pelecypoda	
Sphaerium sp.	1
CRUSTACEA	
Phyllopoda	
Amphipoda	
Isopoda	
Lirceus sp.	1
Decapoda	
Orconectes sp.	1
INSECTA	
PLECOPTERA	
Neophasganophora capitata	9
Neoperla clymene	12
Isoperla clio	3
I. namata	7
Allocapnia sp.	3

EPHEMEROPTERA	
Pseudocloeon sp.	7
Rhithrogenia sp.	23
Baetis sp.	55
Ephemerella invaria	25
E. bicolor	60
Paraleptophlebia praepedita	9
Potomanthus sp.	3
Isonychia sp.	14
Stenonema pulchellum	9
S. nepotellum	18
S. interpunctatum	21
ODONATA	
Gomphidae	8
Argia sp.	4
HEMIPTERA	
NEUROPTERA	
MEGALOPTERA	
Corydalus cornutus	20

TRICOPTERA	
Helicopsyche sp.	6
Caborius sp.	24
Chimarra obscura	4
Cheumatopsyche sp.	30
Hydropsyche bifida	7
LEPIDOPTERA	
COLEOPTERA	
Stenelmis sp. (L)	200
S. sp. (A)	30
Psephenus sp. (L)	40
Optioservus sp. (L)	4
Dubiraphia sp. (L)	2
DIPTERA	
Chyrsops sp.	2
Hexatoma sp.	8
Eriocera sp.	5
Hemerodromia sp.	1
Simulium sp.	3
Tendipedidae	23
MISCELLANEOUS	

REMARKS:

BENTHOS ANALYSIS

STREAM Indian Creek STATION Ei-1 DATE 8-18-64

NUMBER OF ORGANISMS 133 TAXA 21 DIVERSITY

PLATYHELMINTHES

ANNELIDA

MOLLUSCA

Gastropoda

Goniobasis sp.	12
Physa sp.	1

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	1

INSECTA

PLECOPTERA

Neoperla clymene	6
Neophas gonophora capitata	1

EPHEMEROPTERA

Baetis spp.	10
Stenonema nepotellum	4
S. (Gp. S Unk.)	20
S. (near frontale)	2
Heptagenia maculi-	20
pennis	20
Isonychia sp.	9
Caenis sp.	1
Tricorythodes sp.	1
Ephemera sp.	1

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	5

TRICOPTERA

Caborius sp.	1
Cheumatopsyche sp.	1
Chimarra obscura	2

LEPIDOPTERA

COLEOPTERA

Stenelmis sp. (L)	10
S. sp. (A)	2
Psephenus sp. (L)	2
Ectoparia sp.	1

DIPTERA

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Indian Creek STATION Ei-1 DATE 11-3-64

NUMBER OF ORGANISMS 477 TAXA 25 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	2

MOLLUSCA

Gastropoda

Goniobasis sp.	120
Ferrissia sp.	7

Pelecypoda

Sphaerium sp.	8

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Asellus sp. (near stygius)	1

Decapoda

INSECTA
PLECOPTERA

Neoperla clymene	25
Neophasgonophora capitata	2

EPHEMEROPTERA

Ephemera guttulata	4
Baetis sp.	35
Caenis sp.	1
Isonychia sp.	18
Stenonema ares	25
S. tripunctatum	60
S. neoptellum	40
Heptagenia sp.	14

ODONATA

Argia sp.	3
Gomphidae (im.)	1

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	9

TRICOPTERA

Helicopsyche sp.	4
Caborius sp.	8
Cheumatopsyche sp.	14
Empty cases	9

LEPIDOPTERA

COLEOPTERA

Ectoparia sp. (L)	1
Psephenus sp. (L)	19
Stenelmis sp. (L)	22
S. sp. (A)	6
Optioservus sp. (L)	4

DIPTERA

Tendipedidae	15

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Indian Cr. STATION Ei-1 DATE 2-9-65

NUMBER OF ORGANISMS 808 TAXA 41 DIVERSITY

PLATYHELMINTHES

Planaria	2

ANNELIDA

Oligochaeta	9
Hirudinea	1

MOLLUSCA

Gastropoda

Goniobasis sp.	75
Physa sp.	1
Ferrissia sp.	1

Pelecypoda

Sphaerium sp.	2

CRUSTACEA

Phyllopoda

Amphipoda

Gammarus sp.	1

Isopoda

Decapoda

Orconectes sp.	2

INSECTA

PLECOPTERA

Allocapnia sp.	1
Branchyptera fasciata	1
Neoperla clymene	12
Hydroperla nalata	9
Hydroperla crosbyi	12

EPHEMEROPTERA

Paraleptophlebia sp.	11
Isonychia sp.	40
Baetis sp.	8
Potomanthus sp.	4
Ephemerella invaria	12
Leptophlebia sp.	6
Ephemerella bicolor	5
Stenonema tripunctatum	40
S. interpunctatum	25
S. nepotellum	10
S. bipunctatum	50

ODONATA

Argia sp.	4
Gomphidae	2

HEMIPTERA

Macrovelia sp.	1

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	14

TRICOPTERA

Helicopsyche sp.	4
Glossosoma sp.	2
Cheumatopsyche sp.	100

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	10
Ectoparia sp. (L)	2
Stenelmis sp. (L)	20
Optioservus sp. (L)	2

DIPTERA

Chrysops sp.	2
Simulium sp.	1
Tendipedidae	300
Eriocera sp.	2
Antocha sp.	2

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Indian Cr. STATION Ei-1 DATE 5-4-65

NUMBER OF ORGANISMS 218 TAXA 23 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	2

MOLLUSCA

Gastropoda

Goniobasis sp.	18

Pelecypoda

Actinonaias pleasi	

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	1

INSECTA

PLECOPTERA

Neophasganophora capitata	9
Perlesta placida	1
Neoperla clymene	5

EPHEMEROPTERA

Baetis sp.	30
Isonychia sp.	14
Potomanthus sp.	3
Pseudoclocon sp.	5
Ephemerella bicolor	22
Paraleptophlebia praepedita	5
Heptagenia sp	3
Rhithrogenia sp.	11
Stenonema nepotellum	19
S. bipunctatum	7

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

Chimarra obscura	4
Caborius sp.	4
Cheumatopsyche sp.	18

LEPIDOPTERA

COLEOPTERA

Psephenus sp.	9
Stenelmis sp.	12
S. sp.	17

DIPTERA

Hexatoma sp.	1
Tendipedidae	7

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Indian Creek STATION Ei-2 DATE 8-16-64

NUMBER OF ORGANISMS 529 TAXA 25 DIVERSITY

PLATYHELMINTHES

Planaria	3

ANNELIDA

Oligochaeta	1

MOLLUSCA

Gastropoda

Goniobasis sp.	15
Amnicola sp.	1

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp	4

INSECTA

PLECOPTERA

EPHEMEROPTERA

Caenis sp.	45
Ephemera sp.	4
Tricorythodes sp.	140
Isonychia sp.	7
Baetis sp.	35
Choroterpes sp.	23
Stenonema interpunctatum	24
S. pulchellum	50
S. nepotellum	30

ODONATA

Argia sp.	30

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalis sp.	15

TRICOPTERA

Cheumatopsyche sp.	13
Chimarra obscura	11
Psychomyia sp.	1

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	20
Ectoparia sp. (L)	7
Optioservus sp. (L)	13
Stenelmis sp. (L)	25
S. sp. (A)	5

DIPTERA

Chrysops sp.	6
Tabanus sp.	1

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Indian Creek STATION Ei-2 DATE 11-4-64

NUMBER OF ORGANISMS 463 TAXA 20 DIVERSITY

PLATYHELMINTHES

Planaria	4

ANNELIDA

Oligochaeta	3
Hirudinea	2

MOLLUSCA

Gastropoda

Goniobasis sp.	18
Physa sp.	7
Ferrissia sp.	40

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

Neoperla clymene	3

EPHEMEROPTERA

Isonychia sp.	24
Baetis sp.	30
Ephemera guttulata	25
Stenonema interpunctatum	20
S. neoptellum	135

ODONATA

Argia sp.	21

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	10

TRICOPTERA

Cheumatopsyche sp.	40

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	4
Stenelmis sp. (L)	30
S. (A)	12

DIPTERA

Tabanus sp.	3
Tendipedidae	30
Hexatoma sp.	2

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Indian Creek STATION Ei-2 DATE 2-9-65

NUMBER OF ORGANISMS 2274 TAXA 40 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	3
Hirudinea	4

MOLLUSCA

Gastropoda

Goniobasis sp.	30
Ferrissia sp.	100
Physa sp.	25
Gyraulus sp.	3
Amnicola sp.	2

Pelecypoda

Sphaerium sp.	9

CRUSTACEA

Phyllopoda

Amphipoda

Hyalella azteca	1

Isopoda

Decapoda

Orconectes nana	1
O. hylas	1

INSECTA

PLECOPTERA

Isoperla confusa	10
Neoperla sp.	16
Neophasgonophora sp.	9
Isoperla duplicata	14

EPHEMEROPTERA

Isonychia sp.	150
Ephemera guttulata	40
Leptophlebia sp.	25
Paraleptophlebia valentans	50
Potomanthus sp.	8
Stenonema pulchellum	150
S. neoptellum	200
S. tripunctatum	130
S. interpunctatum	220
Ephemerella invaria	25
E. bicolor	16

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	28
Sialis sp.	4

TRICOPTERA

Chimarra obscura	75
Cheumatopsyche sp.	350

LEPIDOPTERA

Cataclysta sp.	1

COLEOPTERA

Psephenus sp. (L)	60
Ectoparia sp. (L)	6
Stenelmis sp. (L)	30
S. (A)	14
Optioservus sp. (L)	12
Microcylloepus sp. (L)	7

DIPTERA

Tendipedidae	400
Chrysops sp.	30
Hexatoma sp.	9

MISCELLANEOUS

Isotomuris palustris	6

REMARKS:

BENTHOS ANALYSIS

STREAM Indian Cr. STATION Ei-2 DATE 5-4-65

NUMBER OF ORGANISMS 922 TAXA 30 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	8

MOLLUSCA

Gastropoda

Goniobasis sp.	2

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Asellus tridentatus	2

Decapoda

INSECTA

PLECOPTERA

Neoperla clymene	16
Isoperla duplicata	7
Perlesta placida	1

EPHEMEROPTERA

Heptagenia sp.	19
Caenis sp.	35
Potomanthus sp.	11
Ephemerella bicolor	11
Ephemera guttulata	5
Baetis sp.	23
Paraleptophlebia sp.	7
Stenonema ares	20
S. tripunctatum	50
S. nepotellum	60
S. interpunctatum	35

ODONATA

Argia sp.	30

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	5

TRICOPTERA

Cheumatopsyche sp.	12
Caborius sp.	2

LEPIDOPTERA

COLEOPTERA

Psephenus sp.	35
Stenelmis sp. (L)	175
S. sp. (A)	150
Optioservus sp. (L)	2

DIPTERA

Tabanus sp.	20
Eriocera sp.	1
Chrysops sp.	2
Hemerodromia sp.	1
Tendipedidae	175

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Elk River STATION E-1 DATE 8-19-64

NUMBER OF ORGANISMS 373 TAXA 30 DIVERSITY

PLATYHELMINTHES

Planaria	2

ANNELIDA

Oligochaeta	8
Hirudinea	3

MOLLUSCA

Gastropoda

Goniobasis sp.	25
Ferrissia sp.	1

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	1

INSECTA

PLECOPTERA

Acroneuria internata	2

EPHEMEROPTERA

Stenonema nepotellum	40
S. Gp. 3 unk.	5
S. frontale	8
Ephemera sp.	1
Tricorythodes sp.	15
Choroterpes sp.	6
Baetis sp.	10
Heptagenia maculipennis	7
Centroptilum sp.	2

ODONATA

Gomphidae (im.)	1
Argia sp.	1

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	16
Sialis sp.	1

TRICOPTERA

Helicopsyche sp	2
Caborius sp.	5
Neophylax autumnus	2
Cheumatopsyche sp.	5
Chimarra obscura	1

LEPIDOPTERA

COLEOPTERA

Stenelmis sp. (A)	80
S. sp. (A)	50
Ectoparia sp. (L)	5
Psephenus sp. (L)	60

DIPTERA

Eriocera sp	2
Tendipedidae	6

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Elk River STATION E-1 DATE 11-3-64

NUMBER OF ORGANISMS 686 TAXA 29 DIVERSITY

PLATYHELMINTHES	
Planaria	7
ANNELIDA	
Oligochaeta	11
Hirudinea	1
MOLLUSCA	
Gastropoda	
Goniobasis sp.	5
Ferrissia sp.	2
Pelecypoda	
Sphaerium sp.	2
CRUSTACEA	
Phyllopoda	
Amphipoda	
Isopoda	
Lirceus sp.	1
Decapoda	
Orconectes sp. (im.)	3
INSECTA	
PLECOPTERA	
Neoperla clymene	70
Neophasgonophora capitata	23

EPHEMEROPTERA	
Baetis sp.	30
Isonychia sp.	80
Stenonema interpunctatum	15
S. bipunctatum	75
S. nepotellum	40
ODONATA	
Argia sp.	3
HEMIPTERA	
NEUROPTERA	
MEGALOPTERA	
Corydalus cornutus	10

TRICOPTERA	
Helicopsyche sp.	12
Caborius sp.	125
Cheumatopsyche sp.	20
Hydropsyche sp.	12
Empty cases	30
LEPIDOPTERA	
COLEOPTERA	
Psephenus sp. (L)	60
Stenelmis sp. (L)	18
S. sp. (A)	9
Optioservus sp. (L)	3
Ectoparia sp. (L)	4
DIPTERA	
Simulium sp.	4
Chrysops sp.	3
Hexatoma sp.	1
Tendipedidae	25
MISCELLANEOUS	

REMARKS:

BENTHOS ANALYSIS

STREAM Elk River STATION E-1 DATE 2-9-65

NUMBER OF ORGANISMS 2600 TAXA 45 DIVERSITY

PLATYHELMINTHES

Planaria	3

ANNELIDA

Oligochaeta	14

MOLLUSCA

Gastropoda

Goniobasis sp.	50
Ferrissia sp.	55
Physa sp.	1
Planorbula sp.	1

Pelecypoda

Sphaerium sp.	9

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	3

INSECTA

PLECOPTERA

Hydroperla nalata	10
Allocapnia sp.	6
Neoperla clymene	50
Neophasgonophora capitata	50
Isoperla clio	1

EPHEMEROPTERA

Isonychia sp.	21
Ephemera guttulata	1
Pseudoclœon sp.	50
Baetis sp.	12
Paraleptophlebia sp.	6
Stenonema bipunctatum	30
S. interpunctatum	80
S. nepotellum	140
S. tripunctatum	55
Ephemerella invaria	100
E. bicolor	350

ODONATA

Argia sp.	6
Gomphidae	4

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	16

TRICOPTERA

Helicopsyche sp.	13
Neophylax sp.	1
Leptocella sp.	3
Leptocerus sp.	25
Agapetus illini	40
Glossosoma sp.	9
Chimarra obscura	14
Hydropsyche bifida	15
Cheumatopsyche sp.	250

LEPIDOPTERA

COLEOPTERA

Ectoparia sp.	24
Psephenus sp. (L)	130
Stenelmis sp. (L)	11
Stenelmis sp. (A)	15
Optioservus sp. (L)	12

DIPTERA

Tendipedidae	900
Eriocera sp.	6
Chrysops sp.	5
Tabanus sp.	2
Tipula sp.	1

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Elk River STATION E-1 DATE 5-4-65

NUMBER OF ORGANISMS 1100 TAXA 37 DIVERSITY

PLATYHELMINTHES	
Planaria	4
ANNELIDA	
Oligochaeta	7
MOLLUSCA	
Gastropoda	
Goniobasis sp.	8
Pelecypoda	
CRUSTACEA	
Phyllopoda	
Amphipoda	
Crangonyx forbesi	7
Isopoda	
Lirceus sp.	9
Decapoda	
Orconectes sp.	1
INSECTA	
PLECOPTERA	
Neoperla clymene	50
Allocapnia sp.	7
Perlesta placida	12

EPHEMEROPTERA	
Ephemera simulans	9
Potamanthus sp.	13
Paraleptophlebia adoptiva	7
P. praepedita	19
Heptagenia sp.	70
Rhithrogenia sp.	22
Stenonema ares	22
S. interpunctatum	70
S. tripunctatum	100
S. nepotellum	50
Baetis sp.	80
Ephemerella invaria	100
E. bicolor	24
ODONATA	
Argia sp.	21
Gomphidae	8
HEMIPTERA	
NEUROPTERA	
MEGALOPTERA	
Corydalus cornutus	5

TRICOPTERA	
Caborus sp.	5
Chimarra obscura	2
Cheumatopsyche sp.	15
Leptocerus sp.	1
LEPIDOPTERA	
COLEOPTERA	
Psephenus sp.	60
Ectoparia sp.	4
Acneus sp.	1
Stenelmis sp.	150
S. sp.	80
Optioserrus sp.	23
DIPTERA	
Hexatoma sp.	9
Tendipedidae	25
MISCELLANEOUS	

REMARKS:

BENTHOS ANALYSIS

STREAM Elk River
STATION E-2
DATE 8-19-64

NUMBER OF ORGANISMS 230
TAXA 33
DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	4

MOLLUSCA

Gastropoda

Goniobasis sp.	70
Planorbidae	1

Pelecypoda

Sphaerium sp.	6
Lampsilis ovata	1

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	1

INSECTA

PLECOPTERA

Acroneuria internata	1
Neoperla clymene	1
Neophasgonophora capitata	1

EPHEMEROPTERA

Stenonema nepotellum	30
S. (near) frontale	12
S. (Gp. 3 Unk)	10
S. ares	1
Tricorythodes sp.	6
Caenis sp.	3
Ephemera sp.	1
Isonychia sp.	2
Choroterpes sp.	8
Baetis sp.	6
Centroptilum sp.	2
Heptagenia sp.	

ODONATA

Argia	2

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	10

TRICOPTERA

Heliocopsyche sp.	2
Neophylax acutumnus	1
Cheumatopsyche sp.	12
Empty case	1

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	6
Ectoparia sp. (L)	2
Stenelmis sp. (L)	20

DIPTERA

Tabanus sp	3
Eriocera sp	1
Tendipedidae	2
Ceratopogonidae	1

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Elk River STATION E-2 DATE 11-3-64

NUMBER OF ORGANISMS 724 TAXA 36 DIVERSITY

PLATYHELMINTHES

Planaria	13

ANNELIDA

Oligochaeta	4

MOLLUSCA

Gastropoda

Goniobasis sp.	25
Ferrissia sp.	2
Somatogyrus sp.	3

Pelecypoda

Sphaerium sp.	25

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp. (im.)	2

INSECTA

PLECOPTERA

Acroneuria internata	1
Neoperla clymene	12
Hydroperla nalata	12
Neophasgonophora capitata	3

EPHEMEROPTERA

Potomanthus sp.	5
Ephemerella invaria	4
Baetis sp.	30
Stenenoma ares	20
S. interpunctatum	15
S. bipunctatum	250
Isonychia sp.	40
Caenis sp.	3

ODONATA

Argia sp.	7
Gomphidae (im.)	1

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	13

TRICOPTERA

Helicopsyche sp.	17
Cheumatopsyche sp.	120
Hydropsyche bifida	4
Neophylax sp.	1
Caborius sp.	12

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	10
Ectoparia sp. (L)	4
Stenelmis sp.	24
Optioservus sp. (L)	6
O. sp. (A)	1

DIPTERA

Chrysops sp.	1
Eriocera sp.	1
Limonia sp.	2
Simulium sp.	1
Tendipedidae	30

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Elk River STATION E-2 DATE 2-9-65

NUMBER OF ORGANISMS 1708 TAXA 38 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	10
Hirudinea	3

MOLLUSCA

Gastropoda

Goniobasis sp.	50
Lymnaea sp.	1
Helisoma sp.	1
Ferrissia sp.	5

Pelecypoda

Sphaerium sp.	5

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	1

INSECTA

PLECOPTERA

Hydroperla nalata	15
Isoperla clio	35
Neophasgonophora capitata	30

EPHEMEROPTERA

Isonychia sp.	75
Ephemerella invaria	130
E. bicolor	45
Stenonema tripunctatum	30
S. interpunctatum	11
S. pulchellum	40
S. bipunctatum	150
Ephemera sp.	1
Baetis sp.	4

ODONATA

Agrionidae	1

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	14

TRICOPTERA

Hydropsyche bifida	16
Helicopsyche sp.	5
Neophylax sp.	5
Caborius sp.	7
Glossosoma sp.	4
Chimarra obscura	1
Cheumatopsyche sp.	350

LEPIDOPTERA

Cataclysta sp.	2

COLEOPTERA

Psephenus sp. (L)	25
Ectoparia sp. (L)	4
Stenelmis sp. (L)	6
Stenelmis sp. (A)	5

DIPTERA

Tendipedidae	600
Simiulium sp.	4
Chrysops sp.	4
Hexatoma sp.	5
Eriocera sp.	7

MISCELLANEOUS

Nematomerpha	1

REMARKS:

BENTHOS ANALYSIS

STREAM Elk River STATION E-2 DATE 5-5-65

NUMBER OF ORGANISMS 613 TAXA 33 DIVERSITY

PLATYHELMINTHES

Planaria	11

ANNELIDA

Oligochaeta	5

MOLLUSCA

Gastropoda

Goniobasis sp.	9
Ferrissia sp.	2

Pelecypoda

Sphaerium sp.	1

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Immature	22

INSECTA

PLECOPTERA

Perlesta placida	17
Neoperla clymene	23
Neophasganophora capitata	18

EPHEMEROPTERA

Potomanthus sp.	3
Ephemera simulans	5
Rhithrogenia sp.	13
Isonychia sp.	16
Heptagenia sp.	35
Paraleptophlebia gutatta	11
P. praepedita	30
Ephemerella bicolor	22
E. invaria	50
Caenis sp.	4
Pseudocloeon sp	7
Stenonema ares	90
S. interpunctatum	40
S. nepotellum	60

ODONATA

Gomphidae	1

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	18

TRICOPTERA

Helicopsyche sp.	2
Neophylax sp	2
Chimarra obscura	18
Cheumatopsyche sp	60
Hydropsyche cuanis	2

LEPIDOPTERA

COLEOPTERA

DIPTERA

Tabanus sp.	3
Stenelmis sp.	11
S. sp	2

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Elk River STATION E-3 DATE 8-20-64

NUMBER OF ORGANISMS 260 TAXA 33 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	6

MOLLUSCA

Gastropoda

Goniobasis sp.	30
Stagnicola sp.	1
Planorbidae	1
Physa spp. (2)	2

Pelecypoda

Adonata grandis	
Lampsilis brevecula	
Leptodea fragilis	

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

Neoperla clymene	1

EPHEMEROPTERA

Stenonema (near) frontale	10
S. (Gp 3 Unk)	4
S. nepotellum	10
S. tripunctatum	2
Ephemera sp.	1
Tricorythodes sp.	6
Choroterpes sp.	6
Baetis sp.	8
Centroptilum sp.	5
Heptagenia maculi-	2
pennis	7
Ephoron album	1
Isonychia sp.	5
Potomanthus sp.	3

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	5

TRICOPTERA

Helicopsyche sp.	15
Caborius sp.	17
Setodes sp.	2
Cheumatopsyche sp.	5

LEPIDOPTERA

COLEOPTERA

Stenelmis spp. (2)	60
S. sp. (L)	30
Psephenus sp. (L)	8

DIPTERA

Eriocera sp	1
Tendipedidae	6

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Elk River STATION E-3 DATE 11=2-64

NUMBER OF ORGANISMS 1,211 TAXA 41 DIVERSITY

PLATYHELMINTHES	
Planaria	2
ANNELIDA	
Oligochaeta	12
MOLLUSCA	
Gastropoda	
Physa sp.	11
Planorbula sp.	3
Goniobasis sp.	16
Ferrissia sp.	7
Pelecypoda	
Sphaerium sp.	3
CRUSTACEA	
Phyllopoda	
Amphipoda	
Isopoda	
Decapoda	
INSECTA	
PLECOPTERA	
Neoperla clymene	75

EPHEMEROPTERA	
Potomanthus sp.	90
Tricorythodes sp.	7
Ephemera varia	30
Caenis sp.	3
Isonychia sp.	60
Baetis sp.	35
Heptagenia sp.	18
Stenonema interpunctatum	45
S. bipunctatum	13
S. tripunctatum	25
S. nepotellum	16
ODONATA	
Argia sp.	30
Gomphidae (im.)	1
Agrionidae (im.)	4
HEMIPTERA	
NEUROPTERA	
MEGALOPTERA	
Corydalus cornutus	16

TRICOPTERA	
Helicopsyche sp.	120
Caborius sp.	55
Leptocella sp.	6
Hydropsyche arinale	2
Chimarra obscura	4
Hydropsyche sp.	12
Cheumatopsyche	200
Empty cases	80
LEPIDOPTERA	
Cataclysta sp.	4
COLEOPTERA	
Psephenus sp. (L)	24
Ectoparia sp. (L)	2
Stenelmis sp. (L)	45
S. sp. (A)	40
Dubiraphia sp. (L)	4
Berosus sp. (L)	1
DIPTERA	
Tabanus sp.	3
Chrysops sp.	4
Hexatoma sp.	6
Eriocera sp.	2
Tendipedidae	75
MISCELLANEOUS	

REMARKS:

BENTHOS ANALYSIS

STREAM Elk River STATION E-3 DATE 2-10-65

NUMBER OF ORGANISMS 1699 TAXA 47 DIVERSITY

PLATYHELMINTHES

Planaria	2

ANNELIDA

Oligochaeta	12
Hirudinea	6

MOLLUSCA

Gastropoda

Goniobasis sp.	24
Planorbula sp.	3
Ferrissia sp.	23
Physa sp.	2

Pelecypoda

Sphaerium sp.	3

CRUSTACEA

Phyllopoda

Amphipoda

Hyalella azteca	1

Isopoda

Decapoda

INSECTA

PLECOPTERA

Isoperla clio	6
Leuctra claasseni	2
Hydroperla nalata	15
Neophasgonophora capitata	3
Neoperla clymene	3

EPHEMEROPTERA

Ephemera varia	40
Potomanthus sp	150
Isonychia sp	75
Leptophlebia sp	21
Stenonema interpunctatum	80
S. tripunctatum	50
S. nepotellum	70
S. pulchellum	200
Heptagenia sp.	35
Ephemeralla walkeri	80
E. invaria	250

ODONATA

Ophiogomphus sp.	2
Argia sp.	13
Aeshna sp.	4

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	7
Sialis sp.	1

TRICOPTERA

Helicopsyche sp.	11
Hydropsyche cuanis	2
Leptocella sp.	3
Polycentropus	3
Neophylax sp.	2
Caborius sp.	2

LEPIDOPTERA

Cataclysta sp.	15

COLEOPTERA

Psephenus sp. (L)	17
Ectoparia sp. (L)	8
Stenelmis sp. (L)	25
Optioservus sp. (L)	12
Dubiraphia sp. (L)	6

DIPTERA

Simulium sp.	1
Eriocera sp.	5
Laccobius sp.	1
Tendipedidae	400

MISCELLANEOUS

Nematomorpha	2

REMARKS:

BENTHOS ANALYSIS

STREAM Elk River STATION E-3 DATE 5-5-65

NUMBER OF ORGANISMS 878 TAXA 30 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	2

MOLLUSCA

Gastropoda

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Lirceus sp.	2

Decapoda

INSECTA

PLECOPTERA

Pteronarcys dorsata	1
Neophasgonophora	1
Neoperla cylmene	110
Perlestra placida	12

EPHEMEROPTERA

Rhithrogenia sp.	20
Potamanthus sp.	9
Isonychia sp.	17
Heptagenia sp.	70
Baetis sp.	40
Paraleptophlebia sp.	2
Stenonema ares	200
S. nepotellum	30
Pseudocleoen sp.	23
Ephemerella invaria	40
E. bicolor	22

ODONATA

Argia sp.	5

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	5

TRICOPTERA

Helicopsyche sp.	19
Caborius sp.	12
Cheumatopsyche sp.	50
Hydropsyche bifida	3
Chimarra obscura	2

LEPIDOPTERA

COLEOPTERA

Stenelmis sp.	40
S. sp.	100
Narpus sp.	3
Psephenus sp.	2

DIPTERA

Tabanus sp.	1
Hexatoma sp.	1
Tendipedidae	35

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Buffalo Creek STATION EB-1 DATE 8-18-64

NUMBER OF ORGANISMS 368 TAXA 22 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	8

MOLLUSCA

Gastropoda

Goniobasis sp.	22
G. sp.	4
Ferrissia sp.	4

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Gammarus sp.	1

Isopoda

Lirceus sp.	40

Decapoda

Orconectes sp.	2

INSECTA
PLECOPTERA

Acroneuria arida	16

EPHEMEROPTERA

Stenonema nepotellum	60
S. tripunctatum	20
S. interpunctatum	1
Isorychia sp.	5
Heptagenia maculi-	9
pennis	1
Baetis sp.	16
Centroptilum sp.	

ODONATA

Gomphidae	1

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	14

TRICOPTERA

Cheumatopsyche sp.	30
Helicopsyche sp.	2

LEPIDOPTERA

COLEOPTERA

Tropisternus sp. (A)	1
Psephenus sp. (A)	3
P. sp. (L)	80
Optioservus sp. (A)	15
O. sp. (L)	2
Stenelmis sp. (A)	6
S. sp. (L)	5

DIPTERA

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Buffalo Creek STATION Eb-1 DATE 11-2-64

NUMBER OF ORGANISMS 226 TAXA 23 DIVERSITY

PLATYHELMINTHES	
ANNELIDA	
Oligochaeta	4
MOLLUSCA	
Gastropoda	
Goniobasis sp.	26
Helisoma sp.	1
Ferrissia sp.	2
Pelecypoda	
CRUSTACEA	
Phyllopoda	
Amphipoda	
Isopoda	
Lirceus sp.	40
Decapoda	
Orconectes sp. (im.)	5
INSECTA	
PLECOPTERA	
Neoperla clymene	9
Acroneuria arida	10
Neophasgonophora capitata	5

EPHEMEROPTERA	
Baetis sp.	16
Isonychia sp.	5
Stenonema interpunctatum	3
S. nepotellum	12
S. tripunctatum	7
S. sp. (im.)	15
ODONATA	
Gomphidae (im.)	1
HEMIPTERA	
NEUROPTERA	
MEGALOPTERA	
Corydalus cornutus	2

TRICOPTERA	
Helicopsyche sp.	10
Cheumatopsyche sp.	12
Hydropsyche sp.	2
Caborius sp.	6
LEPIDOPTERA	
COLEOPTERA	
Psephenus sp. (L)	30
Optioservus sp. (L)	1
Stenelmis sp. (L)	2
DIPTERA	
MISCELLANEOUS	

REMARKS:

BENTHOS ANALYSIS

STREAM Buffalo Cr. STATION Eb-1 DATE 2-10-65

NUMBER OF ORGANISMS 1845 TAXA 40 DIVERSITY

PLATYHELMINTHES

Planaria	30

ANNELIDA

Oligochaeta	19

MOLLUSCA

Gastropoda

Goniobasis sp.	6
Ferrissia sp.	25
Planorbula sp.	1

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Lirceus hoppinae	600

Decapoda

Orconectes peruncus	3

INSECTA

PLECOPTERA

Hydroperla nalata	20
Isoperla richardsoni	50
Allocapnia sp.	15
Isoperla clio	30
Neophasgonophora capitata	40
Acroneuria arida	80

EPHEMEROPTERA

Ephemerella invaria	14
Ephemerella bicolor	3
Isonychia sp.	18
Baetis sp.	35
Stenonema ares	45
S. nepotellum	15
Sipholonurus sp.	4
Heptagenia sp.	30
Paraleptophlebia sp.	6

ODONATA

Gomphidae	2

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	6

TRICOPTERA

Pycnopsyche sp.	1
Helicopsyche sp	50
Glossosoma sp.	30
Cheumatopsyche sp.	250
Chimarra obscura	20
Hydropsyche bifida	9

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	60
Stenelmis sp. (L)	3
Optioservus sp. (L)	6
Optioservus sp. (A)	9

DIPTERA

Tabanus sp.	2
Chrysops sp.	2
Antocha sp.	2
Simulium sp.	3
Tendipedidae	300

MISCELLANEOUS

Acari	1

REMARKS:

BENTHOS ANALYSIS

STREAM Buffalo Cr. STATION Eb-1 DATE 5-5-65

NUMBER OF ORGANISMS 1439 TAXA 37 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	6

MOLLUSCA

Gastropoda

Goniobasis sp.	1

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Allocrangonyx pellucidus	5
Stygobromus sp.	1

Isopoda

Lirceus sp.	225

Decapoda

INSECTA

PLECOPTERA

Neoperla clymene	18
Acroneuria arida	60
Neophasganophora capitata	7
Perlesta placida	6
Isoperla bilineata	1
Allocapnia sp.	3

EPHEMEROPTERA

Paraleptophlebia praepedita	14
Hentagenia sp.	300
Baetis sp.	125
Pseudocloeon sp.	80
Isonychia sp.	75
Rhithrogenia sp.	1
Ephemerella bicolor	35
E. invaria	15
Stenonema ares	50
S. interpunctatum	22
S. nepotellum	25

ODONATA

Gomphidae	2
Argia sp.	1

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	2

TRICOPTERA

Caborius sp.	2
Hydropsyche sp.	55
Polycentropus sp.	3
Limnophilae sp.	1

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	75
Stenelmis sp. (L)	3
S. sp. (A)	15
Optioservus sp. (L)	5
O. sp. (A)	3
Ectoparia sp. (L)	4

DIPTERA

Pseudolimnophila	3
Chrysops sp.	4
Tendipedidae	200

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM James River STATION J-1 DATE 8-3-64

NUMBER OF ORGANISMS 433 TAXA 19 DIVERSITY

PLATYHELMINTHES

Turbellaria	1

ANNELIDA

Oligochaeta	12

MOLLUSCA

Gastropoda

Goniobasis sp.	270
G. sp.	4

Pelecypoda

Actinonaias ellipsiformis	1

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	2

INSECTA

PLECOPTERA

Neoperla clymene	10

EPHEMEROPTERA

Isonychia sp.	20
Baetis sp.	3
Tricorythodes sp.	1
Caenis sp.	2
Stenonema sp. (im.)	9
S. pulchellum	9
S. nepotellum	4
S. ares	15

ODONATA

Gomphidae (im)	1

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus sp.	3

TRICOPTERA

Cheumatopsyche sp.	8
Chimarra obscura	1

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	16
Stenelmis sp. (L)	11
S. (A)	30

DIPTERA

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM James River STATION J-1 DATE 10-19-64

NUMBER OF ORGANISMS 805 TAXA 31 DIVERSITY

PLATYHELMINTHES

Planaria	3

ANNELIDA

Oligochaeta	13

MOLLUSCA

Gastropoda

Goniobasis sp.	200
Ferrissia sp.	17

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Asellus stygius	1

Isopoda

Decapoda

Orconectes sp. (im.)	2

INSECTA

PLECOPTERA

Neoperla clymene	4
Neophasgonophora capitata	22

EPHEMEROPTERA

Isonychia sp.	100
Ephemera guttulata	4
Baetis sp.	60
Paraleptophlebia sp.	2
Pseudocloeon sp.	3
Stenenoma interpunctatum	11
S. bipunctatum	24
S. pulchellum	70
S. nepotellum	32

ODONATA

Argia sp.	20
Gomphidae (im.)	3

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	4

TRICOPTERA

Psilotreta sp.	1
Chimarra obscura	4
Helicopsyche sp.	12
Cheumatopsyche sp.	55

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	70
Stenelmis sp. (L)	11
S. sp. (A)	30
Optioservus sp. (L)	2
Helichus sp. (A)	2

DIPTERA

Simulidae	2
Hexatoma sp.	4
Tendipedidae	17

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM James River STATION J-1 DATE 1-8-65

NUMBER OF ORGANISMS 774 TAXA 35 DIVERSITY

PLATYHELMINTHES

Planaria	9

ANNELIDA

Oligochaeta	25

MOLLUSCA

Gastropoda

Goniobasis sp.	225

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Allocrangonyx sp.	4

Isopoda

Asellus sp.	6

Decapoda

INSECTA

PLECOPTERA

Brachyptera fasciata	25
Neophasgonophora sp.	9
Neoperla sp.	4
Hydroperla sp.	7
Atoperla sp.	15

EPHEMEROPTERA

Ephemera simulans	7
Ephemerella invaria	40
Leptophlebia sp.	4
Potomanthus sp.	2
Isonychia sp.	55
Paraleptophlebia sp.	1
Stenonema ares	14
S. interpunctatum	35
S. tripunctatum	50
S. pulchellum	16

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	3

TRICOPTERA

Helicopsyche sp.	3
Chimarra obscura	5
Caborius sp.	1
Glossosoma sp.	3
Hydropsyche bifida	2
Cheumatopsyche sp.	50

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	75
Stenelmis sp. (L)	2
S. sp. (A)	3

DIPTERA

Simulium sp.	6
Chrysops sp.	2
Tabanus sp.	2
Tipula sp.	2
Tendipedidae	50

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM James River STATION J-1 DATE 4-27-65

NUMBER OF ORGANISMS 244 TAXA 32 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	3

MOLLUSCA

Gastropoda

Goniobasis sp.	4

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

Allocapnia vivipara	3
Neoperla clymene	6
Nemoura venosa	2
Acroneuria arida	1
Neophasganophora capitata	1
Isoperla minuta	11
I. richardsoni	16
Perlesta placida	3

EPHEMEROPTERA

Rhithrogenia sp.	2
Leptophlebia sp.	1
Ephemera simulans	1
Isonychia sp.	22
Ephemerella invaria	9
Pseudocloeon sp.	5
Baetis sp.	13
Heptagenia sp.	36
Stenonema ares	9
S. interpunctatum	5
S. tripunctatum	8
S. pulchellum	36
S. nepotellum	7

ODONATA

Argia sp.	1

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

Chimarra obscura	22
Neophylax sp.	1
Cheumatopsyche sp.	2

LEPIDOPTERA

COLEOPTERA

Stenelmis sp. (L)	4
Stenelmis sp. (A)	5
Psephenus sp. (L)	1

DIPTERA

Tendipedidae	3
Hexatoma sp.	1

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM James River
STATION J-2
DATE 8-3-64
NUMBER OF ORGANISMS 388
TAXA 26
DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	6
Hirudinea	

MOLLUSCA

Gastropoda

Goniobasis sp.	70

Pelecypoda

Sphaerium sp	3
Pleurobema utterbacki	1

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes longidigitus	1
O. sp.	4

INSECTA

PLECOPTERA

Neoperla clymene	1

EPHEMEROPTERA

Caenis sp.	3
Tricorythodes sp.	7
Baetis sp.	20
Isonychia sp.	100
Stenonema pulchellum	45
S. bipunctatum	30
Sipholonurus sp.	5
Choroterpes sp.	5

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus sp.	2
Sialis sp.	2

TRICOPTERA

Chimarra obscura	9
Heliopsyche sp.	6
Cheumatopsyche sp.	10
C. sp. (pupal)	1

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	20
P. sp. (A)	10
Optioservus sp. (L)	3
Stenelmis sp. (L)	2
S. (A)	15

DIPTERA

Tendipedidae	5
Tipulidae	2

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM James River STATION J-2 DATE 10-20-64

NUMBER OF ORGANISMS 601 TAXA 38 DIVERSITY

PLATYHELMINTHES

Planaria	2

ANNELIDA

Oligochaeta	28
Hirudinea	2

MOLLUSCA

Gastropoda

Physa sp.	2
Goniobasis sp.	40
Ferrissia sp.	20

Pelecypoda

Sphaerium sp.	23
Psidium sp.	28

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes menae	2
O. sp. (im.)	3

INSECTA

PLECOPTERA

Acroneuria arida	2
Neophasgonophora capitata	1

EPHEMEROPTERA

Potomanthus sp.	2
Ephemera guttalata	6
Isonychia sp.	25
Caenis sp.	5
Ephemerella sp.	1
Paraleptophlebia sp.	2
Leptophlebia sp.	2
Baetis sp.	16
Stenonema interpunctatum	7
S. bipunctatum	9
S. nepotellum	90
Heptagenia sp.	3

ODONATA

Argia sp.	3
Gomphidae (im.)	2

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	5

TRICOPTERA

Helicopsyche sp.	3
Chimarra obscura	1
C. aterrima	4
Cheumatopsyche sp.	60
Hydropsyche arinale	1

LEPIDOPTERA

COLEOPTERA

Optioservus sp. (L)	1
Psephenus sp. (L)	150
Stenelmis sp. (L)	19
S. sp. (A)	7
Dinetus sp. (A)	1

DIPTERA

Tendipedidae	18
Simulidae	4
Hexatoma sp.	1

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM James River STATION J-2 DATE 1-19-65

NUMBER OF ORGANISMS 629 TAXA 37 DIVERSITY

PLATYHELMINTHES

Planaria	3

ANNELIDA

Oligochaeta	25

MOLLUSCA

Gastropoda

Goniobasis sp.	35
Ferrissia sp.	115

Pelecypoda

Sphaerium sp.	60
Actinonaias ellipsiformis	1

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	3

INSECTA

PLECOPTERA

Taeniopteryx maura	1
Branchyptera fasciata	5
Hydroperla sp.	1
Allocapnia sp.	6

EPHEMEROPTERA

Isonychia sp.	35
Ephemera simulans	7
Ephemerella invaria	12
Ephemerella bicolor	9
Paraleptophlebia praepedita	2
Heptagenia sp.	2
Caenis sp.	1
Stenonema tripunctatum	3
S. pulchellum	15
S. bipunctatum	10
S. nepotellum	4

ODONATA

Agrionidae	2

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	2

TRICOPTERA

Cheumatopsyche sp.	75
Chimarra obscura	7
Helicopsyche sp.	10
Agapetus sp.	40

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	35
Dubiraphia sp. (L)	1
Stenelmis sp. (L)	15
Stenelmis sp. (A)	3
Optioservus sp. (L)	7

DIPTERA

Tipula	2
Simulium sp.	15
Tendipedidae	60
Hexatoma sp.	3

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM James River STATION J-2 DATE 4-27-65

NUMBER OF ORGANISMS 166 TAXA 28 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	15

MOLLUSCA

Gastropoda

Goniobasis sp.	12

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	2

INSECTA

PLECOPTERA

Neoperla clymene	6
Perlesta placida	2
Neophasganophora sp.	4

EPHEMEROPTERA

Potomanthus sp.	10
Ephemerella bicolor	1
E. invaria	14
Heptagenis sp.	5
Ephemera simulans	13
Rhithrogenia sp.	2
Caenis sp.	1
Stenonema ares	11
S. interpunctatum	3
S. tripunctatum	12
S. bipunctatum	7
S. nepotellum	5

ODONATA

Argia sp.	1

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	1

TRICOPTERA

Chimarra obscura	7
Cheumatopsyche sp.	4

LEPIDOPTERA

COLEOPTERA

Psephenus sp.	7
Ectoparia sp.	1
Stenelmis sp.	7

DIPTERA

Protoplasta fitchii	1
Hexatoma sp.	2
Tendipedidae	10

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM James River STATION J-3 DATE 8-5-64

NUMBER OF ORGANISMS 169 TAXA 30 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	1

MOLLUSCA

Gastropoda

Pleurocera sp.	1
Goniobasis sp.	5
G. sp.	3

Pelecypoda

Sphaerium sp.	3
Amblema p. costata	2

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Immature (prob. Orconnectes sp)	2

INSECTA

PLECOPTERA

Neoperla clymene	16

EPHEMEROPTERA

Tricorythodes sp	5
Ephoron album	9
Caenis sp	1
Isonychia sp.	2
Baetis sp.	2
Lepthophlebia sp.	2
Stenonema sp.	10
S. ares	5
S. bipunctatum	4

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus sp.	5
Sialis sp.	1

TRICOPTERA

Cheumatopsyche sp	31
Hydropsyche bifida	13

LEPIDOPTERA

Cataclysta sp.	1

COLEOPTERA

Dinetus sp.	1
Lutrochus sp.	1
Optioservus sp. (L)	4
Stenelmis sp. (L)	4
S. sp. (A)	22

DIPTERA

Tendipedidae	/

MISCELLANEOUS Pelecypoda

Quadrula pustulosa	1
Lagmigona costata	2
Actinonaias ellipsiformis	5
Leptodea fragilis	1
Lampsilis o. ventriculosa	4

REMARKS:

BENTHOS ANALYSIS

STREAM James River STATION J-3 DATE 10-20-64

NUMBER OF ORGANISMS 1,211 TAXA 39 DIVERSITY

PLATYHELMINTHES

Planaria	4

ANNELIDA

Oligochaeta	7
Hirudinea	1

MOLLUSCA

Gastropoda

Goniobasis sp.	25
Ferrissia sp.	3

Pelecypoda

Psidium sp.	12
Sphaerium sp.	80

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	2

INSECTA

PLECOPTERA

Neoperla clymene	100

EPHEMEROPTERA

Tricorythodes sp.	130
Caenis sp.	9
Isonychia sp.	33
Potomanthus sp.	3
Ephemera simulans	7
Heptagenia sp.	11
Stenonema interpunctatum	23
S. pulchellum	72
S. bipunctatum	44

ODONATA

Hetaerina sp.	2
Argia sp.	9

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	14
Sialis sp.	1

TRICOPTERA

Hydropsyche betteni	9
H. bifida	4
Cheumatopsyche sp.	300
Chimarra obscura	14
Protoptila sp.	18
Helicopsyche sp.	5

LEPIDOPTERA

Cataclysta sp.	2

COLEOPTERA

Stenelmis sp. (L)	125
S. sp. (A)	55
Psephenus sp. (L)	7

DIPTERA

Tendipedidae	60
Simulidae	10
Chrysops sp.	1
Atherix variegata	1
Hexatoma sp.	3

MISCELLANEOUS

Actinonaias ellipsiformis	2
Leptodea fragilis	1
Lampsilis o. ventriculosa	2

REMARKS:

BENTHOS ANALYSIS

STREAM James River STATION J-3 DATE 1-25-65

NUMBER OF ORGANISMS 1073 TAXA 42 DIVERSITY

PLATYHELMINTHES

Planaria	6

ANNELIDA

Oligochaeta	15

MOLLUSCA

Gastropoda

Helisoma sp.	5
Lymnaea sp.	1
Goniobasis sp.	38
Physa sp.	
Ferrissia sp.	17

Pelecypoda

Sphaerium sp.	200

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

Taeniopteryx nivalis	2
Allocapnia vivipara	2
Neophasgonophora capitata	1
Neoperla clymene	13
Isoperla confusa	2
Isoperla duplicata	4

EPHEMEROPTERA

Tricorythodes sp.	10
Isonychia sp.	64
Potomanthus sp.	1
Ephemerella gattulata	9
Ephemerella invaria	1
Stenonema tripunctatum	27
Stenonema interpunctatum	40
S. nepotellum	80
S. pulchellum	120
S. bipunctatum	60
Stenonema sp.	70

ODONATA

Hetaerina sp.	4
Argia sp.	10
Gomphidae	1

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	11
Sialis sp.	2

TRICOPTERA

Helicopsyche sp.	2
Chimarra obscura	1
Hydropsyche betteni	11
Cheumatopsyche sp.	90

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	1
Helichus sp. (A)	1
Stenelmis sp. (L)	60
Stenelmis sp. (A)	6

DIPTERA

Tipula sp	5
Atherix variegata	3
Tabanus sp.	1
Tendipedidae	60
Simulidae	16

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM James River STATION J-3 DATE 4-26-65

NUMBER OF ORGANISMS 264 TAXA 19 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	2

MOLLUSCA

Gastropoda

Goniobasis sp.	2

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

Neoperla clymene	43
Perlesta placida	2
Nemoura venosa	1

EPHEMEROPTERA

Caenis sp.	9
Isonychia sp.	6
Rithrogenia sp.	1
Stenonema ares	2
S. bipunctatum	3
S. pulchellum	6
S. tripunctatum	5

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	8

TRICOPTERA

Hydropsyche bifida	2
Cheumatopsyche sp.	2

LEPIDOPTERA

COLEOPTERA

Psephenus sp.	2

DIPTERA

Simulidae	160
Tipula sp.	1
Tendipedidae	7

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM James River STATION J-4 DATE 8-5-64

NUMBER OF ORGANISMS 776 TAXA 46 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	10

MOLLUSCA

Gastropoda

Pleuricera sp.	5
Goniobasis sp.	20
Ferrissia sp.	2

Pelecypoda

Sphaerium sp.	140
Elliptio dilatatus	1

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconctes sp.	8
Cambarus (neardiogenes)	1

INSECTA

PLECOPTERA

Acroneuria arida	2
Neoperla clymene	3

EPHEMEROPTERA

Ephemera guttulata	40
Caenis sp.	6
Choroterpes sp.	4
Baetis sp.	5
Isonychia sp.	90
Heptagenia sp.	8
Ephoron album	7
Sipholonurus sp	4
Tricorythodes sp.	3
Leptophlebia sp.	4
Stenonema gildersleevei	11
S. sp.	25
S. nepotellum	30
S. bipunctatum	25
S. pulchellum	15
S. ares	20

ODONATA

Argia sp.	10

HEMIPTERA

Mesovelia sp.	1
Microvelia sp.	1

NEUROPTERA

MEGALOPTERA

Corydalus sp.	50
Sialis sp.	8

TRICOPTERA

Chimarra obscura	15
Cheumatopsyche spp.	90
C. (pupal)	2
Hydropsyche bifida	4
H. aerata	3
H. simulans	1

LEPIDOPTERA

COLEOPTERA

Brychius sp.	1
Stenelmis sp. (A)	30
S. sp. (L)	40
Psephenus sp. (L)	2

DIPTERA

Tendipedidae	25
Hemerodromia sp.	1

MISCELLANEOUS Pelecypoda

Lasmigona costata	1
Actinonaias carinata	1
Lampsilis r. siliquoides	1
L. o. ventriculosa	1

REMARKS:

BENTHOS ANALYSIS

STREAM James River STATION J-4 DATE 10-21-64

NUMBER OF ORGANISMS 1,011 TAXA 42 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	2

MOLLUSCA

Gastropoda

Ferrissia sp.	6
Amnicola sp.	1
Heliosoma sp.	1
Physa sp.	1
Goniobasis sp.	52

Pelecypoda

Lasmigona costata	1
Actinonaias carinata	1

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes punctimanus	2
O. sp. (im.)	4

INSECTA

PLECOPTERA

Neoperla clymene	6
Neophasgonophora capitata	8

EPHEMEROPTERA

Baetis sp.	4
Tricorythodes sp.	40
Caenis sp.	14
Isonychia sp.	120
Potomanthus sp.	19
Ephemera guttulata	25
Leptophlebia sp.	1
Stenonema interpunctatum	7
S. bipunctatum	4
S. pulchellum	37
S. nepotellum	54

ODONATA

Argia sp.	16

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Sialis sp.	3
Corydalus sp.	42

TRICOPTERA

Hydropsyche bifida	5
H. arinale	2
Hydroptilidae	13
Cheumatopsyche sp.	300
Chimarra obscura	6

LEPIDOPTERA

Cataclysta sp.	1

COLEOPTERA

Psephenus sp. (L)	2
Stenelmis sp. (A)	18
S. sp. (L)	13

DIPTERA

Atherix variegata	2
Scatophagidae	2
Simulidae	2
Tendipedidae	80

MISCELLANEOUS

Pleuricera	15
Lampsilis brevecula	1
Sphaerium sp.	63
Psidium sp.	15

REMARKS:

BENTHOS ANALYSIS

STREAM James River STATION J-4 DATE 1-25-65

NUMBER OF ORGANISMS 1789 TAXA 42 DIVERSITY

PLATYHELMINTHES

Planaria	7

ANNELIDA

Oligochaeta	90

MOLLUSCA

Gastropoda

Pleuricera sp.	8
Goniobasis sp.	37
Ferrissia sp.	27
Helisoma sp.	2

Pelecypoda

Sphaerium sp.	135

CRUSTACEA

Phyllopoda

Amphipoda

Synurella sp.	1

Isopoda

Decapoda

Orconectes sp.	2

INSECTA

PLECOPTERA

Hydroperla nalata	1
Neoperla clymene	9
Perlesta placida	11
Allocapnia vivipara	7
Branchyptera fasciata	1

EPHEMEROPTERA

Tricorythodes sp.	11
Caenis sp.	5
Ephemera guttulata	100
Potomanthus sp.	2
Hexagenia sp.	2
Ephemera simulans	14
Ephemerella invaria	15
Leptophlebia sp.	4
Paraleptophlebia sp.	3
Isonychia sp.	200
Stenonema sp.	40
Stenonema interpunctatum	70
S. tripunctatum	90
S. bipunctatum	50
S. pulchellum	120
S. nepotellum	100

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	7
Sialis sp.	5

TRICOPTERA

Cheumatopsyche sp.	300
Helicopsyche sp.	2
Chimarra obscura	60
Hydroptilidae	7

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	28
Stenelmis sp. (L)	60
Stenelmis sp. (A)	20
Lutrochus sp. (L)	1

DIPTERA

Tabanus sp.	1
Tendipedidae	110
Simulidae	23
Tipula sp.	1

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM James River STATION J-4 DATE 4-28-65

NUMBER OF ORGANISMS 490 TAXA 36 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	2
Hirudinea	2

MOLLUSCA

Gastropoda

Goniobasis sp.	24
Pleuricera sp.	5

Pelecypoda

Sphaerium sp.	1
Elliptio dilatatus	1

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

Neophasganophora capitata	9
Acroneuria arida	2
Perlesta placida	9
Neoperla clymene	8

EPHEMEROPTERA

Isonychia sp.	18
Ephemerella bicolor	5
Pseudocloeon sp.	17
Rhithrogenia sp.	3
Tricorythodes sp.	13
Heptagenia sp.	3
Potomanthus sp.	1
Baetis sp.	2
Stenonema nepotellum	75
S. interpunctatum	13
S. pulchellum	110
S. bipunctatum	3

ODONATA

Argia sp.	2

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	17

TRICOPTERA

Chimarra obscura	2
Cheumatopsyche sp.	3
Hydroptilidae	1

LEPIDOPTERA

COLEOPTERA

Psephenus sp.	7
Stenelmis sp.	40
S. sp.	85
Lutrochus sp.	2

DIPTERA

Hexatoma sp.	1

MISCELLANEOUS - Pelecypoda

Lasmigona costata	1
Anodonta grandis	1
A. imbecillis	1
Lampsilis brevecula	1

REMARKS:

BENTHOS ANALYSIS

STREAM Pearson Cr. STATION Jp-1 DATE 8-5-64

NUMBER OF ORGANISMS 429 TAXA 22 DIVERSITY

PLATYHELMINTHES

Planaria	60

ANNELIDA

Oligochaeta	17
Hirudinea	10

MOLLUSCA

Gastropoda

Goniobasis sp.	110

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Hyalella azteca	4

Isopoda

Decapoda

Orconectes sp. (im)	4

INSECTA

PLECOPTERA

Neoperla clymene	1

EPHEMEROPTERA

Isonychia sp.	3
Stenonema sp.	5
S. interpunctatum	7
S. tripunctatum	5
S. area	5
S. pulchellum	2
Choroterpes basalis	2
Baetis sp.	100
Heptagenia sp.	45
Caenis sp.	4

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus sp.	9

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	6
Optioservus sp. (L)	9
Stenelmis sp. (L)	15

DIPTERA

Tendipedidae	6

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Pearson Creek STATION Jp-1 DATE 10-20-64

NUMBER OF ORGANISMS 1,023 TAXA 36 DIVERSITY

PLATYHELMINTHES	
Planaria	100
ANNELIDA	
Oligochaeta	80
Hirudinea	4
MOLLUSCA	
Gastropoda	
Goniobasis sp.	85
Amnicola sp.	47
Ferrissia sp.	3
Pelecypoda	
Sphaerium sp.	3
CRUSTACEA	
Phyllopoda	
Amphipoda	
Hyalella azteca	1
Isopoda	
Decapoda	
Orconectes sp.	3
INSECTA	
PLECOPTERA	
Acroneuria arida	2
Neoperla clymene	2

EPHEMEROPTERA	
Isonychia sp.	15
Caenis sp.	9
Baetis sp.	150
Ephemera simulans	1
Leptophlebia sp.	3
Pseudocloeon sp.	4
Centroptilum sp.	14
Heptagenia sp.	7
Stenonema ares	18
S. interpunctatum	45
S. pulchellum	75
ODONATA	
Calopterygidae	2
HEMIPTERA	
NEUROPTERA	
MEGALOPTERA	

TRICOPTERA	
Chimarra feria	10
C. obscura	8
Hydropsyche bifida	5
Helicopsyche sp.	1
Cheumatopsyche sp.	12
LEPIDOPTERA	
COLEOPTERA	
Ptilodactylidae	1
Psephenus sp. (L)	86
Narpus sp.	2
Stenelmis sp. (L)	75
S. sp. (A)	2
Optioservus sp. (L)	90
O. sp. (A)	8
DIPTERA	
Simulidae	3
Tendipedidae	30
Tipula sp.	17
MISCELLANEOUS	

REMARKS:

BENTHOS ANALYSIS

STREAM Pearson Creek **STATION** Jp-1 **DATE** 1-18-65

NUMBER OF ORGANISMS 1384 **TAXA** 29 **DIVERSITY**

PLATYHELMINTHES

Planaria	50

ANNELIDA

Oligochaeta	35
Hirudinea	9

MOLLUSCA

Gastropoda

Goniobasis sp.	300
Ferrissia sp.	3

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	3

INSECTA

PLECOPTERA

Neophasgonophora capitata	2
Acroneuria arida	1
Isoperla confusa	1
Brachyptera fasciata	3
Isoperla richardsoni	1

EPHEMEROPTERA

Baetis sp.	35
Heptagenia sp.	7
Isonychia sp.	25
Stenonema ares	1
S. bipunctatum	150
S. pulchellum	9

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	1

TRICOPTERA

Helicopsyche sp.	7
Cheumatopsyche sp.	50
Hydropsyche bifida	3
H. glossonae	3
Agapetus sp.	1
Chimarra obscura	12

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	15
Optioservus sp. (L)	80
O. sp. (A)	2

DIPTERA

Simulium sp.	75
Antocha sp.	1
Tendipedidae	900

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Pearson Cr. STATION Jp-1 DATE 4-27-65

NUMBER OF ORGANISMS 537 TAXA 27 DIVERSITY

PLATYHELMINTHES	
Planaria	3
ANNELIDA	
Oligochaeta	2
Hirudinea	4
MOLLUSCA	
Gastropoda	
Goniobasis sp.	102
Pelecypoda	
Psidium sp.	1
CRUSTACEA	
Phyllopoda	
Amphipoda	
Gammarus fasciatus	13
Isopoda	
Decapoda	
Orconectes sp.	1
INSECTA	
PLECOPTERA	
Perlesta placida	4
Isoperla richardsoni	2
Neophasgonophora capitata	1
Neoperla clymene	1
Nemoura venosa	1

EPHEMEROPTERA	
Caenis sp.	16
Baetis sp.	120
Isonychia sp.	15
Heptagenia sp.	18
Paraleptophlebia sp.	1
Stenonema ares	2
S. interpunctatum	36
S. nepotellum	4
S. pulchellum	18
ODONATA	
HEMIPTERA	
NEUROPTERA	
MEGALOPTERA	

TRICOPTERA	
Cheumatopsyche sp.	15
LEPIDOPTERA	
COLEOPTERA	
Psephenus sp. (L)	6
Optioserrus sp. (L)	6
Stenelmis sp. (L)	8
DIPTERA	
Simuliidae	7
Tendipedidae	130
MISCELLANEOUS	

REMARKS:

BENTHOS ANALYSIS

STREAM Sequiota Creek STATION Js-1 DATE 8-4-64

NUMBER OF ORGANISMS 178 TAXA 13 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	1
Hirudinea	10

MOLLUSCA

Gastropoda

Physa sp.	20

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Immature (prob. Orconectes)	16

INSECTA

PLECOPTERA

EPHEMEROPTERA

Caenis sp.	5
Tricorythodes sp.	2
Centroptilum sp.	25
Baetis sp.	13
Stenonema interpunctatum	35
S. tripunctatum	25

ODONATA

HEMIPTERA

Gerris sp.	1

NEUROPTERA

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

Optioservus sp. (L)	8
O. sp. (A)	10

DIPTERA

Tendipedidae	7

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Sequiota Creek STATION Js-1 DATE 10-19-64

NUMBER OF ORGANISMS 1,737 TAXA 30 DIVERSITY

PLATYHELMINTHES	
Planaria	4
ANNELIDA	
Oligochaeta	11
Hirudinea	24
MOLLUSCA	
Gastropoda	
Physa sp.	110
Lymnea sp.	6
Ferrissia sp.	14
Pelecypoda	
Sphaerium sp.	40
Psidium sp.	17
CRUSTACEA	
Phyllopoda	
Amphipoda	
Isopoda	
Asellus sp.	1
Decapoda	
Orconectes sp. (im.)	6
INSECTA	
PLECOPTERA	

EPHEMEROPTERA	
Caenis sp.	250
Baetis sp.	475
Isonychia sp.	7
Heptagenia sp.	22
Stenonema tripunctatum	85
S. interpunctatum	140
S. sp. (im.)	100
ODONATA	
Argia sp.	27
HEMIPTERA	
Rhagovelia sp.	3
NEUROPTERA	
MEGALOPTERA	
Corydalus cornutus	3

TRICOPTERA	
Cheumatopsyche sp.	40
Hydropsyche simulans	4
Psychomyiid Genus A	2
Hydroptilidae	3
LEPIDOPTERA	
COLEOPTERA	
Psephenus sp. (10	125
Stenelmis sp. (L)	80
S. sp. (A)	60
Optioservus sp. (L)	14
Narpus sp. (L)	2
DIPTERA	
Simulidae	2
Tendipedidae	60
MISCELLANEOUS	

REMARKS:

BENTHOS ANALYSIS

STREAM Sequiota Cr. STATION Js-1 DATE 1-25-65

NUMBER OF ORGANISMS 1281 TAXA 25 DIVERSITY

PLATYHELMINTHES

Planaria	6

ANNELIDA

Oligochaeta	9
Hirudinea	2

MOLLUSCA

Gastropoda

Lymnaea sp.	8
Physa sp.	120
Ferrissia sp.	40

Pelecypoda

Sphaerium sp.	6
Psidium sp.	45

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	3

INSECTA

PLECOPTERA

EPHEMEROPTERA

Isonychia sp.	4
Caenis sp.	80
Baetis sp.	75
Stenonema interpunctatum	140
Stenonema tripunctatum	200

ODONATA

Argia sp.	12

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

Hydropsyche arinale	17
Hydropsyche simulans	50
Cheumatopsyche sp.	7
Chimarra obscura	1

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	30
Stenelmis sp. (A)	7
Optioservus sp. (L)	1
Hydaticus sp. (L)	8

DIPTERA

Simulidae	110
Tendipedidae	300

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Sequiota Cr. STATION Js-1 DATE 4-27-65

NUMBER OF ORGANISMS 313 TAXA 17 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	74
Hirudinea	26

MOLLUSCA

Gastropoda

Physa sp.	4

Pelecypoda

Sphaerium sp	5
Psidium sp.	9

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes eupunctus	1

INSECTA

PLECOPTERA

Perlesta placida	1

EPHEMEROPTERA

Caenis sp.	8
Isonychia sp.	2
Baetis sp.	45
Stenonema tripunctatum	3
S. interpunctatum	31

ODONATA

Argia sp.	8

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

Cheumatopsyche sp.	1

LEPIDOPTERA

COLEOPTERA

Psephenus sp.	7
Stenelmis sp.	41

DIPTERA

Tendipedidae	47

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM James River STATION J-5 DATE 8-5-64

NUMBER OF ORGANISMS 492 TAXA 28 DIVERSITY

PLATYHELMINTHES

Planaria	1

ANNELIDA

Hirudinea	2

MOLLUSCA

Gastropoda

Ferrissia sp.	14
Pleuricera sp.	3
Goniobasis sp.	1

Pelecypoda

Sphaerium	40

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	5

INSECTA
PLECOPTERA

EPHEMEROPTERA

Baetis sp.	35
Tricorythodes sp.	25
Ephoron sp.	2
Ephemera sp.	4
Heptagenia sp.	10
Potamanthus sp.	2
Caenis sp.	60
Choroterpes sp.	3
Isonychia sp.	1
Stenonema interpunctatum	25
S. ares	15
S. tripunctatum	20
S. nepotellum	30
S. bipunctatum	25
S. sp.	25

ODONATA

Argia sp.	10

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Sialis sp.	6
Corydalus sp.	4

TRICOPTERA

Chimarra obscura	2
Cheumatopsyche sp.	10

LEPIDOPTERA

COLEOPTERA

Stenelmis sp. (L)	9
S. (A)	8

DIPTERA

Tendipedidae	95

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM James River STATION J-5 DATE 10-21-64

NUMBER OF ORGANISMS 457 TAXA 22 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	58
Hirudinea	3

MOLLUSCA

Gastropoda

Goniobasis sp.	3
Ferrissia sp.	7
Pleuricera sp.	3

Pelecypoda

Lampsilis r. siliquoides	1
Sphaerium sp.	19

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp. (im.)	11
O. nais	2

INSECTA

PLECOPTERA

EPHEMEROPTERA

Ephemera simulans	12
Potomanthus sp.	7
Caenis sp.	120
Baetis sp.	5
Stenonema interpunctatum	55
S. tripunctatum	70
S. bipunctatum	7

ODONATA

Argia sp.	47

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Sialis sp.	3
Corydalus cornutus	5

TRICOPTERA

Cheumatopsyche sp.	7

LEPIDOPTERA

COLEOPTERA

Ectoparia sp. (L)	2
Stenelmis sp. (L)	7
S. sp. (A)	2

DIPTERA

Tendipedidae	1

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM James River STATION J-5 DATE 2-2-65

NUMBER OF ORGANISMS 648 TAXA 23 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	30
Hirudinea	4

MOLLUSCA

Gastropoda

Ferrissia sp.	30
Goniobasis sp.	4
Pleurocera sp.	6

Pelecypoda

Sphaerium sp.	100

CRUSTACEA

Phyllopoda

Amphipoda

Hyallella azteca	7
Gammarus sp.	30

Isopoda

Decapoda

Orconectes sp.	21

INSECTA

PLECOPTERA

EPHEMEROPTERA

Potomanthus sp.	2
Stenonema tripunctatum	60
S. interpunctatum	10
Caenis sp.	140

ODONATA

Argia sp.	15

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	3
Sialis sp.	6

TRICOPTERA

Cheumatopsyche sp.	4

LEPIDOPTERA

COLEOPTERA

Ectoparia sp. (L)	2
Limnius sp. (A)	1
Stenelmis sp. (L)	2

DIPTERA

Simulium sp.	3
Tendipedidae	165

MISCELLANEOUS

Cladocera	3

REMARKS:

BENTHOS ANALYSIS

STREAM James River STATION J-5 DATE 4-28-65

NUMBER OF ORGANISMS 429 TAXA 33 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	29
Hirudinea	6

MOLLUSCA

Gastropoda

Amnicola sp.	1
Goniobasis sp.	3

Pelecypoda

Sphaerium sp.	1
Carunculina glans	1
Lampsilis r. siliguoides	1

CRUSTACEA

Phyllopoda

Amphipoda

Crangonyx sp.	10

Isopoda

Lirceus sp.	1

Decapoda

Orconectes luteus	2

INSECTA

PLECOPTERA

Neoperla clymene	2
Perlesta placida	3

EPHEMEROPTERA

Caenis sp.	40
Isonychia sp.	7
Pseudocloeon sp.	4
Baetis sp.	9
Heptagenia sp.	2
Tricorythodes sp.	1
Stenonema pulchellum	3
S. tripunctatum	1
S. interpunctatum	3
S. bipunctatum	1

ODONATA

Argia sp.	4

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	4

TRICOPTERA

Chimarra obscura	2
Hydropsyche simulans	1
H. betteni	1
Cheumatopsyche sp.	1

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	1
Stenelmis sp. (A)	2

DIPTERA

Tipula sp.	1
Chrysops sp.	1
Tendipedidae	280

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM James River STATION J-6 DATE 8-5-64

NUMBER OF ORGANISMS 1326 TAXA 33 DIVERSITY

PLATYHELMINTHES

Planaria	15
Hirudinea	13

ANNELIDA

Oligochaeta	7

MOLLUSCA

Gastropoda

Ferrissia sp.	6
Goniobasis sp.	12
Pleurocera sp.	12
Pleurocera	6

Pelecypoda

Sphaerium sp.	400
Sphaerium sp.	50

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	4

INSECTA

PLECOPTERA

EPHEMEROPTERA

Isonychia sp.	60
Stenonema sp.	35
Stenonema nepotellum	17 55
Baetis sp.	25
Centroptilum sp.	15
Caenis sp.	6
Tricorythodes sp.	11

ODONATA

Argia	4
Gomphidae (1mm)	1

HEMIPTERA

1 Species	1

NEUROPTERA

MEGALOPTERA

Corydalus	45

TRICOPTERA

Cheumatopysche sp.	90
Hydropsyche bifida	3
H. aerata	1
Chimarra obscura	1

LEPIDOPTERA

Elophila sp.	3

COLEOPTERA

Stenelmis sp. (L)	110
S. sp. (A)	9
Optioservus sp. (L)	80
O. sp. (A)	2
Helichus sp. (A)	2

DIPTERA

Simulidae	20
Tipulidae	2
Tendipedidae	200

MISCELLANEOUS -Pelecypoda

Pleurobema c. coccineum	1
P. utterbacki	1
Lampsilis o. ventriculosa	1

REMARKS:

BENTHOS ANALYSIS

STREAM James River STATION J-6 DATE 10-22-64

NUMBER OF ORGANISMS 2,918 TAXA 37 DIVERSITY

PLATYHELMINTHES

Planaria	16

ANNELIDA

Oligochaeta	7
Hirudinea	12

MOLLUSCA

Gastropoda

Goniobasis sp.	22
Pleuricera sp.	53
Ferrissia sp.	45

Pelecypoda

Sphaerium sp.	1000
Psidium sp.	15

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes neglectus	5

INSECTA

PLECOPTERA

Acroneuria arida	1
Neophasgonophora capitata	4

EPHEMEROPTERA

Tricorythodes sp.	300
Caenis sp.	16
Isonychia sp.	90
Ephemera simulans	35
Potomanthus sp.	5
Choroterpes sp.	3
Leptophlebia sp.	2
Baetis sp.	120
Stenonema ares	17
S. interpunctatum	45
S. bipunctatum	220
S. nepotellum	80

ODONATA

Argia sp.	8

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Sialis sp.	2
Corydalus cornutus	100

TRICOPTERA

Chimarra obscura	7
Cheumatopsyche sp.	275
Hydropsyche aerata	1
H. bifida	3

LEPIDOPTERA

COLEOPTERA

Stenelmis sp. (L)	150
S. sp. (A)	35
Dubiraphia sp. (L)	2
Optioservus sp. (L)	35
O. sp. (A)	1
Elsianus sp. (A)	2

DIPTERA

Atherix variegata	3
Hexatoma sp.	1
Tendipedidae	80

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM James River STATION J-6 DATE 2-2-65

NUMBER OF ORGANISMS 2503 TAXA 39 DIVERSITY

PLATYHELMINTHES

Planaria	32

ANNELIDA

Oligochaeta	23
Hirudinea	36

MOLLUSCA

Gastropoda

Pleuricera sp.	11
Goniobasis sp.	20
Ferrissia sp.	45
Helisoma sp.	2
Amnicola sp.	1

Pelecypoda

Sphaerium sp.	120

CRUSTACEA

Phyllopoda

Amphipoda

Synurella sp.	2

Isopoda

Decapoda

Orconectes ozarkae	1

INSECTA

PLECOPTERA

Branchyptera fasciata	4
Hydroperla nalata	1
Allocapnia vivipara	2
Neophasgonophora capitata	6
Isoperla richardsoni	2

EPHEMEROPTERA

Caenis sp.	50
Tricorythodes sp.	7
Potomanthus sp.	5
Isonychia sp.	180
Ephemera simulans	50
Leptophlebia sp.	3
Pseudocloeon sp.	1
Stenonema sp.	35
S. tripunctatum	100
S. bipunctatum	200
S. nepotellum	100
S. pulchellum	50

ODONATA

Argia sp.	5

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	80

TRICOPTERA

Cheumatopsyche sp.	400
Chimarra obscura	9
Hydropsyche bifida	15
Hydroptilidae	25

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	80
Ectoparia sp. (L)	7
Stenelmis sp. (L)	70
Stenelmis sp. (A)	18
Optioservus sp. (L)	15

DIPTERA

Simulidae (L)	180
Simulidae (P)	30
Tendipedidae (L)	180
Tendipedidae (P)	300

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM James River STATION J-6 DATE 4-29-65

NUMBER OF ORGANISMS 285 TAXA 27 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	4
Hirudinea	6

MOLLUSCA

Gastropoda

Pelecypoda

Pleurobema utterbacki	2
Lampsilis o. ventriculosa	2

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

Perlesta placida	15
Isoperla richardsoni	2
Neophasganophora capitata	3

EPHEMEROPTERA

Caenis sp.	17
Isonychia sp.	26
Ephemerella invaria	13
Paraleptophlebia praepedita	14
Heptagenia sp.	5
Baetis sp.	21
Pseudocloeon sp.	1
Stenonema pochellum	15
S. bipunctatum	20
S. tripunctatum	35
S. interpunctatum	6
S. ares	

ODONATA

Gomphidae	1
Argia sp.	1

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	21

TRICOPTERA

Cheumatopsyche sp.	5
Chimarra obscura	5

LEPIDOPTERA

COLEOPTERA

Psephenus sp.	2
Stenelimis sp.	11

DIPTERA

Tendipedidae	28
Simulidae	4

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM James River STATION J-7 DATE 8-6-64

NUMBER OF ORGANISMS 603 TAXA 37 DIVERSITY

PLATYHELMINTHES

Planaria	3

ANNELIDA

MOLLUSCA

Gastropoda

Goniobasis sp.	135
Pleuricera sp.	20
Ferrissia sp.	1

Pelecypoda

Sphaerium sp.	3
Cyclonaias tuberculata	1

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	1

INSECTA

PLECOPTERA

EPHEMEROPTERA

Caenis sp.	8
Tricoythodes sp.	9
Sipholonorus sp.	1
Ephemera sp.	20
Isonychia sp.	45
Choroterpes sp.	8
Baetis sp.	25
Heptagenia sp.	15
Stenonema sp.	25
S. ares	45
S. nepotellum	70
S. bipunctatum	20

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus sp.	15
Sialis sp.	2

TRICOPTERA

Heliocopsyche sp.	5
Tascobia sp.	16
Cheumatopsyche sp.	6
Hydropsyche sp.	2
H. aerata	1

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	3
Optioservus sp. (L)	20
Ectoparia sp. (L)	8
Stenelmis sp. (L)	30
S. sp. (A)	12

DIPTERA

Tendipedidae	20
Tipulidae	1

~~MISCELLANEOUS~~ Pelecypoda

Pleurobema c. coccineum	2
Elliptio dilatatus	1
Lasmigona costata	2
Actonanaias c. carinata	1
Lampsilis sp.	1

REMARKS:

BENTHOS ANALYSIS

STREAM James River STATION J-7 DATE 10-29-64

NUMBER OF ORGANISMS 416 TAXA 34 DIVERSITY

PLATYHELMINTHES

Planaria	1

ANNELIDA

Hirudinea	1
Oligochaeta	21

MOLLUSCA

Gastropoda

Pleuricera sp.	35
Goniobasis	80
Gyraulus sp.	1

Pelecypoda

Actinonaias c. carinata	1
Lampsilis sp.	1
L. o. ventriculosa	1

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes menae	4

INSECTA

PLECOPTERA

Neoperla clymene	1
Perlesta placida	21
Neophasgonophora capitata	27

EPHEMEROPTERA

Ephemera guttulata	5
Potomanthus sp.	18
Caenis sp.	14
Isonychia sp.	13
Ephemerella bicolor	2
E. invaria	63
Heptagenia sp.	4
Stenonema bipunctatum	23
S. interpunctatum	5
S. nepotellum	14

ODONATA

Argia sp.	1
Gomphidae (im.)	2

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	11

TRICOPTERA

Cheumatopsyche sp.	3
Neophylax sp.	1
Helicopsyche sp.	1

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	3
Ectoparia sp. (L)	1
Stenelmis sp. (L)	28
S. sp. (A)	5
Optioservus sp. (L)	3
Argromyx sp. (L)	1

DIPTERA

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM James River STATION J-7 DATE 2-3-65

NUMBER OF ORGANISMS 2414 TAXA 45 DIVERSITY

PLATYHELMINTHES

Planaria	17

ANNELIDA

Oligochaeta	14
Hirudinea	4

MOLLUSCA

Gastropoda

Goniobasis sp.	43
Pleuricera sp.	13
Ferrissia sp.	40

Pelecypoda

Sphaerium sp.	7
Psidium sp.	12

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Lirceus sp.	1

Decapoda

INSECTA

PLECOPTERA

Hydroperla nalata	2
Taeniopteryx navalis	6
Branchyptera fasciata	1
Neophasgonophora capitata	8

EPHEMEROPTERA

Potomanthus sp.	30
Ephemera guttulata	60
Isonychia sp.	85
Leptophlebia sp.	6
Tricorythodes sp.	22
Ephemerella invaria	14
E. bicolor	10
Baetis sp.	7
Pseudocloeon sp.	5
Stenonema sp.	80
S. tripunctatum	50
S. bipunctatum	200
S. nepotellum	90
S. pulchellum	100
S. interpunctatum	35

ODONATA

Argia sp.	16
Gomphidae	2

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	16
Sialis sp.	1

TRICOPTERA

Chimarra obscura	1
Cheumatopsyche sp.	77
Helicopsyche sp.	1

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	42
Ectoparia sp. (L)	3
Lutrochus sp. (L)	1
Dubiraphia sp. (L)	2
Stenelmis sp. (L)	110
Stenelmis sp. (A)	4
Optioservus sp. (L)	19

DIPTERA

Tipula sp.	1
Atherix variegata	4
Limonia sp.	2
Tendipedidae	1000
Simulidae	150

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM James River STATION J-7 DATE 4-29-65

NUMBER OF ORGANISMS 200 TAXA 24 DIVERSITY

PLATYHELMINTHES

ANNELIDA

MOLLUSCA

Gastropoda

Goniobasis sp.	18
Pleuricera sp.	11

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

Neophasganophora capitata	1
Perlesta placida	9
Neoperla clymene	1

EPHEMEROPTERA

Caenis sp.	18
Ephemera guttulata	2
Potomanthus sp.	8
Isonychia sp.	3
Ephemerella bicolor	2
E. invaria	22
Heptagenia sp.	3
Stenonema ares	9
S. bipunctatum	20
S. pulchellum	14
S. nepotellum	36

ODONATA

Gomphidae	1

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

Cheumatopsyche sp.	2

LEPIDOPTERA

COLEOPTERA

Pelonomus sp.	1
Stenelmis sp. (L)	5
S. sp. (A)	2
Optioservus sp. (L)	4

DIPTERA

Tipula sp.	1
Tendipedidae	7

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM James River STATION J-8 DATE 8-6-64

NUMBER OF ORGANISMS 880 TAXA 38 DIVERSITY

PLATYHELMINTHES	
Planaria	10
ANNELIDA	
Oligochaeta	10
Hirudinea	2
MOLLUSCA	
Gastropoda	
Goniobasis sp.	90
Pleuricera sp.	30
Pelecypoda	
Actinonaias carinata	1
Lampsilis o. ventriculosa	1
CRUSTACEA	
Phyllopoda	
Amphipoda	
Isopoda	
Decapoda	
INSECTA	
PLECOPTERA	
Acroneuria sp.	1
Neophasgonophora capitata	1

EPHEMEROPTERA	
Isonychia sp.	100
Tricorythodes sp.	8
Ephemera sp.	80
Potamanthus sp.	3
Ephoron leukon	2
Caenis sp.	7
Baetis sp.	45
Centroptillum sp.	7
Leptophlebia sp.	9
Stenonema sp.	35
S. ares	80
S. interpunctatum	15
S. nepotellum	60
Ephemera guttulata	12
ODONATA	
Argia sp.	9
HEMIPTERA	
NEUROPTERA	
MEGALOPTERA	
Corydalus	35
Sialis sp.	10

TRICOPTERA	
Cheumatopsyche sp.	40
Helicopsyche	1
Hydropsyche sp.	15
H. sp. (pupal)	1
LEPIDOPTERA	
Elophila sp.	2
Cataclysta sp.	7
COLEOPTERA	
Psephenus sp. (L)	2
Optioservus sp. (A)	1
O. sp. (L)	12
Stenelmis sp. (L)	80
S. sp. (A)	8
DIPTERA	
Hemerodromia sp.	2
Simulium sp.	5
Tendipedidae	40
MISCELLANEOUS Pelecypoda	
Lampsilis brevecula	1

REMARKS:

BENTHOS ANALYSIS

STREAM James River STATION J-8 DATE 10-22-64

NUMBER OF ORGANISMS 676 TAXA 22 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	13

MOLLUSCA

Gastropoda

Goniobasis sp.	126
Pleuricera sp.	29

Pelecypoda

Sphaerium sp.	
Actinonaias carinata	1

CRUSTACEA

Phyllopoda

Amphipoda

Synurella sp.	2

Isopoda

Lirceus sp.	120

Decapoda

Orconectes sp.	2

INSECTA

PLECOPTERA

Neophasgonophora capitata	4

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	30
Sialis sp.	2

TRICOPTERA

Cheumatopsyche sp.	180
Chimarra obscura	4
Hydropsyche aerata	8
H. simulans	4
H. bifida	4
H. betteni	1

LEPIDOPTERA

COLEOPTERA

Stenelmis sp. (L)	75
S. sp. (A)	14

DIPTERA

Tendipedidae	40
Simulidae	9
Ceratopogonidae	7
Chrysops sp.	1

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM James River STATION J-8 DATE 2-3-65

NUMBER OF ORGANISMS 1564 TAXA 37 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	8
Hirudinea	12

MOLLUSCA

Gastropoda

Pleuricera sp.	7
Goniobasis sp.	26
Ferrissia sp.	12

Pelecypoda

Sphaerium sp.	9
Lampsilis o. ventriculosa	1

CRUSTACEA

Phyllopoda

Amphipoda

Synurella sp.	1

Isopoda

Decapoda

INSECTA

PLECOPTERA

Taeniopteryx nivalis	10
Allocapnia sp.	2
Neoperla clymene	1
Neophasgonophora capitata	1

EPHEMEROPTERA

Potomanthus sp.	12
Isonychia sp.	150
Ephemera simulans	50
Caenis sp.	4
Tricorythodes sp.	3
Leptophlebia sp.	14
Stenonema sp.	150
S. interpunctatum	75
S. tripunctatum	60
S. bipunctatum	9
S. pulchellum	90
S. neopotellum	140
Heptagenia sp.	21

ODONATA

Argia sp.	17
Gomphidae	3

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	40

TRICOPTERA

Cheumatopsyche sp.	200

LEPIDOPTERA

Cataclysta sp.	1

COLEOPTERA

Stenelmis sp. (L)	21
S. sp. (A)	1
Optioservus sp. (L)	6
O. sp. (A)	1
Dubiraphia sp. (L)	2

DIPTERA

Tabanus sp.	1
Tendipedidae	300
Simulidae	100
Atherix variegata	1

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM James River STATION J-8 DATE 4-29-65

NUMBER OF ORGANISMS 283 TAXA 25 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	3
Hirudinea	1

MOLLUSCA

Gastropoda

Goniobasis sp.	10
Pleuricera sp.	4

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	1

INSECTA

PLECOPTERA

Perlesta placida	40
Neophasganophora capitata	16
Neoperla clymene	6

EPHEMEROPTERA

Isonychia sp.	10
Potomanthus sp.	12
Tricorythodes sp.	9
Ephemera simulans	3
Ephemerella invaria	11
Heptagenia sp.	4
Stenonema ares	4
S. interpunctatum	14
S. tripunctatum	60
S. pulchellum	13
S. nepolellum	7

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	7

TRICOPTERA

Cheumatopsyche sp.	7

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	1
Optioservus sp. (L)	1
Stenelmis sp. (L)	8

DIPTERA

Tendipedidae	28

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Wilson Creek STATION Jw-1 DATE 8-4-64

NUMBER OF ORGANISMS 1705 TAXA 6 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	1000

MOLLUSCA

Gastropoda

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

EPHEMEROPTERA

Baetis sp.	1
Callibaetis sp.	2

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

Dinetus sp. (A)	1
Laccophilus sp. (A)	1

DIPTERA

Tendipedidae	700

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Wilson Creek
STATION Jw-1
DATE 10-30-64

NUMBER OF ORGANISMS 7,000
TAXA 2
DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	2000

MOLLUSCA

Gastropoda

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

DIPTERA

Tendipedidae	5000

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Wilson Cr. STATION Jw-1 DATE 1-19-65

NUMBER OF ORGANISMS 3015 TAXA 3 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta 2000

MOLLUSCA

Gastropoda

Physa sp. 15

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

DIPTERA

Tendipedidae 1000

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Wilson Cr. STATION Jw-1 DATE 4-27-65

NUMBER OF ORGANISMS 1660 TAXA 2 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	1600

MOLLUSCA

Gastropoda

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

DIPTERA

Tendipedidae	60

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Rader Spring STATION (Jwsp-1) DATE 8-4-64

NUMBER OF ORGANISMS 2130 TAXA 3 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta 100

MOLLUSCA

Gastropoda

Physa sp. 30

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

DIPTERA

Tendipedidae 2000

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Rader Spring STATION Jwsp-1 DATE 10-20-64

NUMBER OF ORGANISMS 5,232 TAXA 3 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta 3000

MOLLUSCA

Gastropoda

Physa sp. 32

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

DIPTERA

Tendipedidae 2200

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Rader Spring STATION Jwsp-1 DATE 1-19-65

NUMBER OF ORGANISMS 2016 TAXA 4 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	500
Hirudinea	1

MOLLUSCA

Gastropoda

Physa sp.	15

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

DIPTERA

Tendipedidae	1500

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Rader Spring STATION Jwsp-1 DATE 4-28-65

NUMBER OF ORGANISMS 811 TAXA 3 DIVERSITY

PLATYHELMINTHES

ANNELIDA
Oligochaeta 750

MOLLUSCA
Gastropoda
Physa sp. 16

Pelecypoda

CRUSTACEA
Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA
PLECOPTERA

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

DIPTERA
Tendipedidae 45

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Wilson Cr. STATION Jw-2 DATE 8-4-64

NUMBER OF ORGANISMS 388 TAXA 9 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	20

MOLLUSCA

Gastropoda

Physa sp.	12

Pelecypoda

Lampsilis brevecula	1

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Immature	1

INSECTA

PLECOPTERA

EPHEMEROPTERA

Callibaetis sp.	1

ODONATA

HEMIPTERA

Corixidae	1

NEUROPTERA

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

Tropisternus sp. (A)	1
Stenelmis sp. (A)	1

DIPTERA

Tendipedidae	300-400

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Wilson Creek STATION Jw-2 DATE 10-21-64

NUMBER OF ORGANISMS 2,465 TAXA 4 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta 200

MOLLUSCA

Gastropoda

Physa sp. 64

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp. 1

INSECTA

PLECOPTERA

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

DIPTERA

Tendipedidae 2200

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Wilson Cr. STATION Jw-2 DATE 1-19-65

NUMBER OF ORGANISMS 1766 TAXA 4 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta 1500

MOLLUSCA

Gastropoda

Physa sp. 40

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

Cheumatopsyche sp. 1

LEPIDOPTERA

COLEOPTERA

DIPTERA

Tendipedidae 225

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Wilson Cr. STATION Jw-2 DATE 4-28-65

NUMBER OF ORGANISMS 1300 TAXA 2 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	900

MOLLUSCA

Gastropoda

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

DIPTERA

Tendipedidae	400

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Finley Creek STATION Jf-1 DATE 8-20-64

NUMBER OF ORGANISMS 309 TAXA 30 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	13
Hirudinea	1

MOLLUSCA

Gastropoda

Goniobasis sp.	130

Pelecypoda

Actinonaias pleasi	1
Lampsilis brevecula	1

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	3

INSECTA

PLECOPTERA

Acroneuria arida	1

EPHEMEROPTERA

Caenis sp.	6
Tricorythodes sp.	2
Pentagenia sp.	2
Isonychia sp.	14
Baetis sp.	3
Heptagenia sp.	4
Stenonema sp. (im.)	12
S. interpunctutum	25
S. nepotellum	30
S. pulchellum	2

ODONATA

Lanthus sp	15
Argia sp	1

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus sp.	4
Chauliodes sp.	2
Sialis sp.	1

TRICOPTERA

Helicopsyche sp.	12
Chimarra obscura	1
Hydropsyche sp	2
Caborius sp.	1

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (I)	8
Ectoparia ap. (I)	1
Stenelmis sp (I)	7
S. sp. (A)	2

DIPTERA

Atherix sp.	2
Tendipedidae	

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Finley Creek STATION Jf-1 DATE 10-31-64

NUMBER OF ORGANISMS 757 TAXA 30 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	21

MOLLUSCA

Gastropoda

Goniobasis sp.	300
Helisoma sp.	3
Ferrissia sp.	17

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp. (im.)	2

INSECTA

PLECOPTERA

Acroneuria arida	4
Neoperla clymene	9
Neophasgonophora capitata	1

EPHEMEROPTERA

Ephemera simulans	10
Isonychia sp.	60
Baetis sp.	3
Paraleptophlebia moerens	2
Caenis sp.	2
Tricorythodes sp.	1
Stenonema ares	25
S. nepotellum	100
S. interpunctatum	17
S. sp.	20

ODONATA

Gomphidae (im.)	18
Argia sp.	4

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	15

TRICOPTERA

Chimarra obscura	21
Helicopsyche sp.	2
Doliophilus sp.	3
Leptocella sp.	8
Cheumatopsyche sp.	5
Psychomyiidae (im.)	3
Empty cases	5

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	22
Stenelmis sp. (L)	2
S. sp. (A)	14
Optioservus sp. (L)	3

DIPTERA

Tendipedidae	35

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Finley Cr. STATION Jf-1 DATE 2-8-65

NUMBER OF ORGANISMS 698 TAXA 37 DIVERSITY

PLATYHELMINTHES

Planaria	4

ANNELIDA

Oligochaeta	30

MOLLUSCA

Gastropoda

Goniobasis sp.	200
Pleurocera sp.	2
Ferrissia sp.	6

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Allocrangonyx sp.	3

Isopoda

Decapoda

Orconectes sp.	2

INSECTA

PLECOPTERA

Acroneuria arida	3
Neoperla clymene	7
Isoperla duplicata	3
Allocapnia sp.	2

EPHEMEROPTERA

Ephemera guttulata	4
Ephemerella bicolor	3
E. serrata	2
E. invaria	6
Leptophlebia sp.	2
Baetis sp.	6
Isonychia sp.	80
Stenonema interpunctatum	25
S. nepotellum	50
S. tripunctatum	10

ODONATA

Gomphidae	12
Argia sp.	10

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	9

TRICOPTERA

Helicopsyche sp.	1
Chimarra obscura	4
Psychomyia sp.	1
Glossosoma sp.	2
Cheumatopsyche sp.	9

LEPIDOPTERA

Cataclysta sp.	1

COLEOPTERA

Psephenus sp. (L)	130
Stenelmis sp. (A)	9
Optioservus sp. (L)	2

DIPTERA

Tipula sp.	1
Simulium sp.	4
Tendipedidae	50
Atherix sp.	3

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Finley Cr. STATION Jf-1 DATE 5-3-65

NUMBER OF ORGANISMS 253 TAXA 27 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	6

MOLLUSCA

Gastropoda

Goniobasis sp.	32

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

Neophasganorphora capitata	14
Neoperla clymene	16
Aoroneuria arida	3
Perlesta placida	2

EPHEMEROPTERA

Rhithrogenia sp.	2
Isonychia sp.	23
Paraleptophlebia sp.	27
Baetis sp.	11
Ephemerella invaria	23
E. serrata	2
Heptagenia sp.	9
Tricorythodes sp.	1
Stenonema ares	9
S. tripunctatum	4
S. pulchellum	6
S. nepotellum	27

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	4

TRICOPTERA

Chimarra obscura	6
Pschomyiid genus A	1
Cheumatopsyche sp.	12

LEPIDOPTERA

COLEOPTERA

Stenelmis sp. (L)	3
S. sp. (A)	2
Helichus sp. (A)	2
Psephenus sp. (L)	5

DIPTERA

Chrysops sp.	1

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Finley Creek STATION Jf-2 DATE 8-20-64

NUMBER OF ORGANISMS 268 TAXA 22 DIVERSITY

PLATYHELMINTHES

Planaria	1

ANNELIDA

Oligochaeta	6
Hirudinea	1

MOLLUSCA

Gastropoda

Ferrissia sp.	2
Pleuricera sp.	2
Goniobasis sp.	150

Pelecypoda

Sphaerium sp.	4

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp	1

INSECTA

PLECOPTERA

EPHEMEROPTERA

Caenis sp.	10
Isonychia sp.	6
Stenonema ares	8
S. nepotellum	5

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	16

TRICOPTERA

Cheumatopsyche sp.	10
Heliocopsyche sp.	3
Chimarra socia	6
C. obscura	3

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	9
Helichus sp. (A)	1
Optioservus sp. (L)	2
O.	3
Stenelmis sp. (L)	4
S. sp. (A)	11

DIPTERA

Chrysops sp.	2
Tabanus sp.	2

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Finley Creek STATION Jf-2 DATE 10-31-64

NUMBER OF ORGANISMS 519 TAXA 34 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	23
Hirudinea	5

MOLLUSCA

Gastropoda

Goniobasis sp.	200
Pleuricera sp.	1

Pelecypoda

Sphaerium sp.	5
Fusconaia ozarkensis	1

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes longidigitus	1
O. neglectus	2

INSECTA

PLECOPTERA

Neophasgonophora capitata	2

EPHEMEROPTERA

Isonychia sp.	23
Ephemera simulans	5
Potomanthus sp.	1
Tricorythodes sp.	3
Caenis sp.	8
Baetis sp.	6
Stenonema ares	3
S. bipunctatum	80
S. pulchellum	14
S. interpunctatum	14

ODONATA

Gomphidae (im.)	1
Argia sp.	4

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	8

TRICOPTERA

Hydropsyche bifida	3
Cheumatopsyche sp.	45
Helicopsyche sp.	2
Chimarra obscura	4

LEPIDOPTERA

Cataclysta sp.	1

COLEOPTERA

Stenelmis sp. (A)	18
S. sp. (L)	6
Ectoparia sp. (L)	1
Psephenus sp. (L)	20

DIPTERA

Tendipedidae	5
Tabanus sp.	1

~~MISCELLANEOUS~~ Pelecypoda

Actinoaias pleasi	2
Lampsilis brevicula	1

REMARKS:

BENTHOS ANALYSIS

STREAM Finley Cr. STATION Jf-2 DATE 2-8-65

NUMBER OF ORGANISMS 408 TAXA 33 DIVERSITY

PLATYHELMINTHES

Planaria	4

ANNELIDA

Oligochaeta	3
Hirudinea	1

MOLLUSCA

Gastropoda

Goniobasis sp.	300
Ferrissia sp.	6

Pelecypoda

Sphaerium sp.	2

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	2

INSECTA

PLECOPTERA

Acroneuria arida	1
Hydroperla nalata	2

EPHEMEROPTERA

Baetisca bajkovi	1
Isonychia sp.	80
Caenis sp.	2
Ephemerella bicolor	24
Leptophlebia sp.	1
Stenonema interpunctatum	14
S. bipunctatum	25
S. pulchellum	40

ODONATA

Aeshnidae	3
Agrionidae	2

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	14

TRICOPTERA

Chimarra obscura	14
Hydropsyche bifida	5
Cheumatopsyche sp.	125
Helicopsyche sp.	6

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	75
Ectoparia sp. (L)	3
Stenelmis sp. (L)	25
Stenelmis sp. (A)	5
Lutrochus sp. (L)	1

DIPTERA

Simulium sp.	17
Tendipedidae	300
Eriocera sp.	3
Chrysops sp.	1

MISCELLANEOUS

Acari	1

REMARKS:

BENTHOS ANALYSIS

STREAM Finley Cr. STATION JF-2 DATE 5-3-65

NUMBER OF ORGANISMS 179 TAXA 30 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	3
Hirudinea	1

MOLLUSCA

Gastropoda

Goniobasis sp	40

Pelecypoda

Psidium sp	1
Sphaerium sp	1
Lasmigona costata	1

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp	1

INSECTA

PLECOPTERA

Neoperla clymene	5
Acroneuria arida	5
Nemoura sp	1
Perlesta placida	2

EPHEMEROPTERA

Isonychia sp.	16
Rhithrogenia sp.	6
Ephemerella serrata	10
E. bicolor	3
Pseudocleoen sp.	3
Baetis sp.	6
Paraleptophlebia sp.	3
Heptagenia sp.	5
Caenis sp.	4
Stenonema nepotellum	7
S. interpunctatum	4
S. pulchellum	2
S. bipunctatum	5

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	9

TRICOPTERA

Chimarra obscura	9
Helicopsyche sp.	1
Cheumatopsyche sp.	12

LEPIDOPTERA

COLEOPTERA

DIPTERA

Stenelmis sp.	3
S. sp.	10

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Finley Cr. STATION Jf-3 DATE 8-20-64

NUMBER OF ORGANISMS 327 TAXA 11 DIVERSITY

PLATYHELMINTHES

Planaria	7

ANNELIDA

Oligochaeta	7

MOLLUSCA

Gastropoda

Ferrissia sp.	35
Goniobasis sp.	13

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Hyalella azetca	2

Isopoda

Decapoda

Immature	4

INSECTA
PLECOPTERA

EPHEMEROPTERA

Baetis sp.	2

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

Chimarra obscura	1

LEPIDOPTERA

COLEOPTERA

Stenelmis sp. (L)	2
Stenelmis sp. (A)	4

DIPTERA

Tendipedidae	140

MISCELLANEOUS ANNELIDA

Hirudinea	110

REMARKS:

BENTHOS ANALYSIS

STREAM Finley Creek STATION Jf-3 DATE 10-31-64

NUMBER OF ORGANISMS 270 TAXA 10 DIVERSITY

PLATYHELMINTHES

Planaria	70

ANNELIDA

Oligochaeta	50
Hirudinea	52

MOLLUSCA

Gastropoda

Gyraulus sp.	1
Goniobasis sp.	25
Ferrissia sp.	44

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Hyalella azteca	3

Isopoda

Decapoda

Orconectes luteus	3

INSECTA

PLECOPTERA

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	3
P. sp. (A)	1

DIPTERA

Tendipedidae	18

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Finley Cr. STATION F-3 DATE 2-8-65

NUMBER OF ORGANISMS 408 TAXA 9 DIVERSITY

PLATYHELMINTHES

Planaria	2

ANNELIDA

Hirudinea	120

MOLLUSCA

Gastropoda

Goniobasis sp.	32
Ferrissia sp.	110
Amnicola sp.	1

Pelecypoda

Psidium sp.	5

CRUSTACEA

Phyllopoda

Amphipoda

Hyalella azteca	3

Isopoda

Decapoda

INSECTA

PLECOPTERA

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

DIPTERA

Tendipedidae	130
Simulidae	5

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Finley Cr. STATION Jf-3 DATE 5-3-65

NUMBER OF ORGANISMS 102 TAXA 11 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Hirudinea	2

MOLLUSCA

Gastropoda

Pelecypoda

Fusconaia ozarkensis	2
Proptera purpurata	1
Lampsilis brevicula	1

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

EPHEMEROPTERA

Isonychia sp.	2
Baetis sp.	1
Heptagenia sp.	2
Stenonema ares	5
S. tripunctatum	2
S. nepotellum	9

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

DIPTERA

Tendipedidae	75

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Finley Creek STATION Jf-4 DATE 8-20-64

NUMBER OF ORGANISMS 259 TAXA 23 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	3
Hirudinea	1

MOLLUSCA

Gastropoda

Goniobasis sp.	60
Ferrissia sp.	1

Pelecypoda

Musculium sp.	8

CRUSTACEA

Phyllopoda

Amphipoda

Gammarus sp.	8

Isopoda

Decapoda

Orconectes sp. (im)	4

INSECTA

PLECOPTERA

EPHEMEROPTERA

Isonychia sp.	10
Baetis sp.	20
Tricorythodes sp.	4
Caenis sp.	6
Stenonema ares	8
S. nepotellum	16
S. pulchellum	3
S. sp. (im)	17

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus sp.	19

TRICOPTERA

Helicopsyche sp.	1
Neophylax sp. (L)	1
Chimarra obscura	3
Cheumatopsyche sp.	30

LEPIDOPTERA

COLEOPTERA

Berosus sp. (L)	1
Psephenus sp. (L)	6
Stenelmis sp. (L)	25
S. sp. (A)	3

DIPTERA

Tabanus sp.	1

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Finley Creek STATION Jf-4 DATE 10-31-64

NUMBER OF ORGANISMS 540 TAXA 25 DIVERSITY

PLATYHELMINTHES

Planaria	2

ANNELIDA

Oligochaeta	27
Hirudinea	1

MOLLUSCA

Gastropoda

Goniobasis sp.	200
Lymnaea sp.	2
Ferrissia sp.	14

Pelecypoda

Sphaerium sp.	4

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes menae	4

INSECTA

PLECOPTERA

EPHEMEROPTERA

Isonychia sp.	33
Baetis sp.	14
Tricorythodes sp.	4
Caenis sp.	6
Stenonema tripunctatum	9
S. bipunctatum	49
S. nepotellum	30

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	7

TRICOPTERA

Neophylax sp.	2
Cheumatopsyche sp.	80
Chimarra obscura	7

LEPIDOPTERA

COLEOPTERA

Ectoparia sp. (L)	6
Psephenus sp. (L)	4
Stenelmis sp. (L)	9
S. sp. (A)	5
Pelonomis sp. (A)	1

DIPTERA

Tendipedidae	14
Simulidae	6

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Finley Cr. STATION Jf-4 DATE 2-8-65

NUMBER OF ORGANISMS 2055 TAXA 33 DIVERSITY

PLATYHELMINTHES

Planaria	1

ANNELIDA

Oligochaeta	40
Hirudinea	5

MOLLUSCA

Gastropoda

Goniobasis sp.	175
Ferrissia sp.	21
Helisoma sp.	3

Pelecypoda

Sphaerium sp.	50

CRUSTACEA

Phyllopoda

Amphipoda

Crangonyx sp.	6

Isopoda

Lirceus sp.	1

Decapoda

Orconectes sp.	5

INSECTA

PLECOPTERA

Isoperla sp.	4
Allocapnia sp.	145

EPHEMEROPTERA

Heptagenia sp.	1
Isonychia sp.	80
Ephemerella invaria	55
Ephemera varia	1
Caenis sp.	4
Stenonema ares	80
S. bipunctatum	140
S. tripunctatum	75

ODONATA

Argia sp.	3

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	10

TRICOPTERA

Chimarra obscura	25
Cheumatopsyche sp.	220
Hydropsyche sp.	10

LEPIDOPTERA

Cataclysta sp.	1

COLEOPTERA

Psephenus sp. (L)	25
Ectoparia sp. (L)	9
Stenelmis sp. (L)	20
Stenelmis sp. (A)	9
Optioservus sp. (A)	2

DIPTERA

Simulium sp.	125
Tendipedidae	700

MISCELLANEOUS

Nematomorpha	4

REMARKS:

BENTHOS ANALYSIS

STREAM Finley Cr. STATION Jf-4 DATE 5-3-65

NUMBER OF ORGANISMS 145 TAXA 28 DIVERSITY

PLATYHELMINTHES

Planaria	1

ANNELIDA

Oligochaeta	2

MOLLUSCA

Gastropoda

Pleuricera sp.	1
Goniobasis sp.	44

Pelecypoda

Sphaerium sp.	1
Fusconaia ozarkensis	1
Amblema p. costata	3

CRUSTACEA

Phyllopoda

Amphipoda

Gammarus fasciatus	8

Isopoda

Lirceus sp.	17

Decapoda

Orconectes sp.	1

INSECTA

PLECOPTERA

EPHEMEROPTERA

Heptagenia sp.	1
Caenis sp.	1
Paraleptophlebia sp.	1
Stenonema interpunctatum	1
Pseudocloeon sp.	4
Baetis sp.	10

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

Chimarra obscura	1
Cheumatopsyche sp.	2

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	2
Stenelmis sp. (L)	8
S. sp. (A)	11

DIPTERA

Tipula sp.	1
Tendipedidae	17

MISCELLANEOUS - Pelecypoda

Lasmigona costata	1
Strophitus undulatus	1
Lampsilis r. siliguoidas	2
L. o. ventriculosa	1
L. brevicula	1

REMARKS:

BENTHOS ANALYSIS

STREAM Crane Cr. STATION Jc-1 DATE 8-6-64

NUMBER OF ORGANISMS 243 TAXA 22 DIVERSITY

PLATYHELMINTHES

ANNELIDA

MOLLUSCA

Gastropoda

Goniobasis sp.	125
Pleuricera sp.	5
Ferrissia sp.	2
Physa sp.	1

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	1

INSECTA

PLECOPTERA

Acroneuria arida	1

EPHEMEROPTERA

Tricorythodes sp.	3
Sipholonurus sp.	2
Baetis sp.	4
Isonychia sp.	10
Stenonema sp.	7
S. interpunctatom	6
S. pulchellum	4
S. nepotellum	30

ODONATA

Argia sp.	6

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus sp.	12
Sialis sp.	6

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

Narpus sp. (A)	1
Psepherus sp. (L)	3
Stenelmis sp. (L)	4
S. sp. (A)	2
Optioservus sp. (L)	6

DIPTERA

Tendipedidae	2

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Crane Creek STATION Jc-1 DATE 10-21-64

NUMBER OF ORGANISMS 542 TAXA 31 DIVERSITY

PLATYHELMINTHES

Planaria	2

ANNELIDA

Oligochaeta	16

MOLLUSCA

Gastropoda

Goniobasis sp.	32
Pleuricera sp.	6
Ferrissia sp.	8

Pelecypoda

Fusconaia ozarkensis	4
Actinonaias pleasi	1

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

Allocapnia sp.	1

EPHEMEROPTERA

Caenis sp.	14
Isonychia sp.	165
Ephemera guttulata	1
Tricorythodes sp.	12
Pseudocloeon sp.	6
Baetis sp.	9
Heptagenia sp.	4
Stenonema ares	22
S. interpunctatum	9
S. bipunctatum	60
S. nepotellum	25

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	10
Sialis sp.	1

TRICOPTERA

Hydropsyche bifida	9
Helicopsyche sp. (case)	1
Chimarra obscura	4
Cheumatopsyche sp.	10

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	34
Stenelmis sp. (L)	27
S. sp. (A)	22
Optioservus sp. (L)	21
O. sp. (A)	1
Narpus sp. (L)	2

DIPTERA

~~MISCELLANEOUS~~ Pelecypoda

Lampsilis breuicula	2
Ptychobranchus occidentalis	1

REMARKS:

BENTHOS ANALYSIS

STREAM Crane Creek STATION Jc-1 DATE 2-3-65

NUMBER OF ORGANISMS 974 TAXA 29 DIVERSITY

PLATYHELMINTHES

Planaria	1

ANNELIDA

MOLLUSCA

Gastropoda

Goniobasis sp.	45
Pleuricera sp.	7
Ferrissia sp.	4
Amnicola sp.	2

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Lirceus sp.	1

Decapoda

INSECTA

PLECOPTERA

Allocapnia	6
Hydroperla nalata	5
Branchyptera fasciata	3

EPHEMEROPTERA

Isonychia sp.	350
Ephemerella invaria	35
Pseudocloeon sp.	75
Stenonema ares	80
S. bipunctatum	150
S. pulchellum	45
Caenis sp.	1

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	12

TRICOPTERA

Chimarra obscura	3
Hydropsyche bifida	14
Hydropsyche sp.	5
Cheumatopsyche sp.	3
Agapetus sp.	14

LEPIDOPTERA

COLEOPTERA

Stenelmis sp. (A)	1
Narpus sp. (L)	1
Optioservus sp. (L)	25
Psephenus sp. (L)	13

DIPTERA

Tipula sp.	5
Simulium sp.	8
Tendipedidae	60

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Crane Creek STATION Jc-1 DATE 4-19-65

NUMBER OF ORGANISMS 826 TAXA 42 DIVERSITY

PLATYHELMINTHES

Planaria	1

ANNELIDA

Oligochaeta	14

MOLLUSCA

Gastropoda

Goniobasis sp.	75
Somatogyrus sp.	1
Pleuricera sp.	7
Ferrissia sp.	6

Pelecypoda

Sphaerium sp.	4
Psidium sp.	2

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Lirceus sp.	7

Decapoda

Orconectes sp.	3

INSECTA

PLECOPTERA

Perlesta placida	

EPHEMEROPTERA

Caenis sp.	80
Tricorythodes sp.	2
Isonychia sp.	80
Potomanthus sp.	8
Ephemera guttulata	1
Heptagenia sp.	40
Ephemerella invaria	50
E. bicolor	7
Baetis sp.	4
Pseudocleon sp.	2
Stenonema ares	75
S. interpunctatum	40
S. pulchellum	60
S. nepotellum	120
S. bipunctatum	25

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	3
Chauliodes sp.	1

TRICOPTERA

Helicopsyche sp.	12
Hydropsyche bifida	1
Cheumatopsyche sp.	7
Psychomyiid genus A	1

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	40
Ectoparia sp. (L)	2
Stenelmis sp. (L)	5
S. sp. (A)	3
Optioservus sp. (L)	7
O. sp. (A)	1
Chelonarium sp. (L)	1

DIPTERA

Hemerodromia sp.	1
Atherix variegata	2
Tendipedidae	20
Simulidae	6

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Flat Creek STATION Jfl-1 DATE 8-19-64

NUMBER OF ORGANISMS 294 TAXA 29 DIVERSITY

PLATYHELMINTHES

Turbellaria	5

ANNELIDA

Oligochaeta	1
Hirudinea	1

MOLLUSCA

Gastropoda

Goniobasis sp.	8

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Lirceus sp.	20

Decapoda

Orconectes sp.	3

INSECTA

PLECOPTERA

EPHEMEROPTERA

Stenonema (near ares)	2
S. tripunctatum	15
S. (near gildersleevi)	7
S. interpunctatum	15
S. sp. (im.)	30
Isonychia sp.	20
Choroterpes sp.	7
Baetis sp.	50
Caenis sp.	3
Pseudocloeon sp.	2
Heptagenia maculipennis	9

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus sp.	10

TRICOPTERA

Hydropsyche bifida	20
Cheumatopsyche sp.	40
Helicopsyche sp.	1
Chimarra aterrima	5
C. sp. (pupal)	1
Hydropsyche sp. (pupal)	1

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	1
Stenelmis sp. (L)	6
S. sp. (A)	3
Optioservus sp. (A)	2

DIPTERA

Eriocera sp.	2
Simulium sp.	4
Tendipedidae (not keyed)	

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Flat Creek STATION Jf1-1 DATE 11-1-64

NUMBER OF ORGANISMS 786 TAXA 25 DIVERSITY

PLATYHELMINTHES

Planaria	18

ANNELIDA

Hirudinea	1

MOLLUSCA

Gastropoda

Goniobasis sp.	13
Ferrissia sp.	1

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Lirceus sp.	35

Decapoda

Orconectes menae	6

INSECTA

PLECOPTERA

EPHEMEROPTERA

Caenis sp.	10
Isonychia sp.	150
Heptagenia sp.	15
Baetis sp.	220
Pseudocloeon sp.	7
Stenonema ares	270
S. interpunctatum	5
S. bipunctatum	21
S. pulchellum	12

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	8

TRICOPTERA

Chimarra obscura	16
Hydropsyche bifida	42
Hydroptilidae	3
Cheumatopsyche sp.	88

LEPIDOPTERA

COLEOPTERA

Optioservus sp. (L)	1
Psephenus sp. (L)	3

DIPTERA

Hexatoma sp.	12
Simulidae	7
Tendipedidae	30

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Flat Cr. STATION Jfl-1 DATE 2-9-65

NUMBER OF ORGANISMS 1781 TAXA 28 DIVERSITY

PLATYHELMINTHES

Planaria	22

ANNELIDA

Oligochaeta	2

MOLLUSCA

Gastropoda

Goriobasis sp.	12
Ferrissia sp.	2

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Lirceus sp.	75

Decapoda

Orconectes sp.	3

INSECTA

PLECOPTERA

Isoperla decepta	2

EPHEMEROPTERA

Isonychia sp.	80
Sipholonurus sp.	25
Baetis sp.	75
Paraleptophlebia sp.	3
Stenonema interpunctatum	18
S. tripunctatum	120
S. bipunctatum	45

ODONATA

Gomphidae	1
Argia sp.	1

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	9

TRICOPTERA

Chimarra obscura	80
Hydropsyche bifida	150
Cheumatopsyche	500
Helicopsyche sp.	4

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	1
Optioservus sp. (L)	6
Optioservus sp. (A)	1

DIPTERA

Tabanus sp.	1
Tipula sp.	1
Simulium sp.	120
Eriocera sp.	22
Tendipedidae	400

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Flat Creek STATION Jf1-1 DATE 5-3-65

NUMBER OF ORGANISMS 1692 TAXA 33 DIVERSITY

PLATYHELMINTHES

Planaria	3

ANNELIDA

Hirudinea	1

MOLLUSCA

Gastropoda

Physa sp.	5
Goniobasis sp.	8

Pelecypoda

Sphaerium sp.	1
Psidium sp.	1

CRUSTACEA

Phyllopoda

Amphipoda

Synurella sp.	7
Allocrangonyx pellucidus	1

Isopoda

Lirceus sp.	800

Decapoda

Orconectes eupunctus	1

INSECTA

PLECOPTERA

Perlesta placida	1
Neoperla clymene	1

EPHEMEROPTERA

Isonychia sp.	320
Caenis sp.	36
Pseudocloeon sp.	23
Baetis sp.	120
Centroptilum sp.	7
Stenonema pulchellum	55
S. interpunctatum	45
S. tripunctatum	9
S. nepotellum	5
Heptagenia sp.	48

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	4

TRICOPTERA

Chimarra obscura	1
Cheumatopsyche sp.	7

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	4
Stenelmis sp. (L)	60
S. sp. (A)	7
Optioservus sp. (A)	1

DIPTERA

Tabanus sp.	2
Tendipedidae	53
Simulidae	10
Hexatoma sp.	45

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Flat Creek STATION Jf1-2 DATE 8-6-64

NUMBER OF ORGANISMS 229 TAXA 24 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	3

MOLLUSCA

Gastropoda

Physa sp.	2
Goniobasis sp.	50
Pleuricera sp.	1

Pelecypoda

Alasmidonta calceolus	1
Lampsilis brevicula	2

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	1

INSECTA

PLECOPTERA

Neoperla clymene	1

EPHEMEROPTERA

Isonychia sp.	40
Caenis sp.	7
Baetis sp.	5
Stenonema sp.	15
S. tripunctatum	2
S. pulchellum	12
S. nepotellum	25

ODONATA

Gomphidae (im)	1

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus sp.	10

TRICOPTERA

Chimarra obscura	10
Cheumatopsyche sp.	10
Helicopsyche sp.	4

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	4
Stenelmis sp. (L)	10

DIPTERA

Dicranota sp.	5
Tendipedidae	8

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Flat Creek STATION Jfl-2 DATE 11-1-64

NUMBER OF ORGANISMS 414 TAXA 23 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	9

MOLLUSCA

Gastropoda

Goniobasis sp.	120
Physa sp.	1
Pleuricera sp.	4

Pelecypoda

Sphaerium sp.	1

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	1

INSECTA

PLECOPTERA

EPHEMEROPTERA

Isonychia sp.	6
Ephemera simulans	6
Caenis sp.	2
Stenonema tripunctatum	8
S. bipunctatum	14
S. pulchellum	80

ODONATA

Gomphidae (im.)	1

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	10

TRICOPTERA

Chimarra obscura	120
Helicopsyche sp.	4
Cheumatopsyche sp.	10

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	1
Stenelmis sp. (L)	4
S. sp. (A)	1

DIPTERA

Tipula sp.	2
Tabanus sp.	2
Hexatoma sp.	2
Atherix variegata	5

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Flat Cr. STATION Jfl-2 DATE 2-9-65

NUMBER OF ORGANISMS 1063 TAXA 31 DIVERSITY

PLATYHELMINTHES

Planaria	8

ANNELIDA

Oligochaeta	4

MOLLUSCA

Gastropoda

Goniobasis sp.	300
Ferrissia sp.	2
Pleuricera sp.	4

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

Allocapnia sp.	30
Branchyptera fasciata	9
Neoperla sp.	1

EPHEMEROPTERA

Baetisca lacustris	2
Ephemerella invaria	25
Pseudocloeon sp.	7
Isonychia sp.	140
Stenonema ares	80
S. pulchellum	50
S. bipunctatum	60

ODONATA

Argia sp.	3
Gomphidae	2

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	3

TRICOPTERA

Chimarra obscura	10
Cheumatopsyche sp.	16
Glossosoma sp.	25
Helicopsyche sp.	3
Neophylax sp.	4

LEPIDOPTERA

Cataclysta sp	1

COLEOPTERA

Psephenus sp. (L)	6
Stenelmis sp. (L)	2
Optioservus sp. (L)	4

DIPTERA

Simulium sp.	2
Tendipedidae	250
Atherx sp.	9

MISCELLANEOUS

Acari	1

REMARKS:

BENTHOS ANALYSIS

STREAM Flat Cr
STATION Jf1-2
DATE 5-3-65

NUMBER OF ORGANISMS 73
TAXA 16
DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	7

MOLLUSCA

Gastropoda

Goniobasis sp.	2

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

Pteronarcys sp.	4
Perlesta placida	1

EPHEMEROPTERA

Potomanthus sp.	4
Isonychia sp.	3
Ephemera guttulata	1
Ephemerella bicolor	4
E. serrata	10
Stenonema interpunctatum	1
Baetis sp.	1

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

Cheumatopsyche sp.	14

LEPIDOPTERA

COLEOPTERA

Ectoparia sp. (L)	1
Psephenus sp. (L)	14
Heliphorus sp. (L)	1

DIPTERA

Tendipedidae	5

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Spring River **STATION** S-1 **DATE** 9-14-64

NUMBER OF ORGANISMS 161 **TAXA** 21 **DIVERSITY**

PLATYHELMINTHES

Planaria	11

ANNELIDA

Oligochaeta	1
Hirudinea	2

MOLLUSCA

Gastropoda

Ferrissia sp.	1

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Allocrangonyx pellucides	1

Isopoda

Lirceus sp.	2

Decapoda

Orconectes nana	8

INSECTA

PLECOPTERA

EPHEMEROPTERA

Ephemera guttulata	2
Baetis sp.	7
Choroterpes sp.	16
Habrophlebia sp.	2
Caenis sp.	30
Tricorythodes sp.	5
Stenonema tripunctatum	3
S. bipunctatum	15
S. interpunctatum	2

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Sialis sp.	1

TRICOPTERA

Helicopsyche sp.	8
Empty cases	3

LEPIDOPTERA

COLEOPTERA

Optioservus sp. (L)	1

DIPTERA

Tendipedidae	25
Sarcophagidae	15

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Spring River STATION S-1 DATE 12-15-64

NUMBER OF ORGANISMS 800 TAXA 13 DIVERSITY

PLATYHELMINTHES

Planaria	2

ANNELIDA

Oligochaeta	200

MOLLUSCA

Gastropoda

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp. (im.)	9

INSECTA

PLECOPTERA

EPHEMEROPTERA

Caenis sp.	1
Stenonema bipunctatum	1

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Sialis sp.	1

TRICOPTERA

Hydropsyche bifida	15
Cheumatopsyche sp.	55
Neureclipsis crepuscularis	9
Rhyacophila sp.	1

LEPIDOPTERA

COLEOPTERA

Optioservus sp. (L)	3

DIPTERA

Tendipedidae	500
Simulium sp.	3

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Spring River STATION S-1 DATE 3-10-65

NUMBER OF ORGANISMS 781 TAXA 25 DIVERSITY

PLATYHELMINTHES

Planaria	2

ANNELIDA

Oligochaeta	110
Hirudinea	2

MOLLUSCA

Gastropoda

Pelecypoda

Sphaerium sp.	2

CRUSTACEA

Phyllopoda

Amphipoda

Hyalella azteca	2

Isopoda

Asellus sp.	40

Decapoda

Orconectes sp.	4

INSECTA

PLECOPTERA

EPHEMEROPTERA

Ephemera guttulata	1
Stenonema tripunctatum	10
S. interpunctatum	6
S. ares	9
Caenis sp.	25
Baetis sp.	12
Leptophlebia sp.	3

ODONATA

Lanthus sp.	4

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

Helicopsyche sp.	3
Phryganea sp.	4
Cheumatopsyche sp.	6
Glossosoma sp.	1
Neophylax sp.	1

LEPIDOPTERA

COLEOPTERA

Optioservus sp. (L)	24

DIPTERA

Tendipedidae	500
Eriocera sp.	5
Marvina sp.	1

MISCELLANEOUS

Acari	4

REMARKS:

BENTHOS ANALYSIS

STREAM Spring R. STATION S-1 DATE 5-31-65

NUMBER OF ORGANISMS 1650 TAXA 33 DIVERSITY

PLATYHELMINTHES	
Planaria	5
ANNELIDA	
Oligochaeta	14
Hirudinea	2
MOLLUSCA	
Gastropoda	
Pelecypoda	
Sphaerium sp.	6
CRUSTACEA	
Phyllopoda	
Amphipoda	
Bacturus sp.	3
Isopoda	
Lirceus sp.	200
Decapoda	
Orconectes sp.	16
INSECTA	
PLECOPTERA	

EPHEMEROPTERA	
Caenis sp.	120
Baetis sp.	200
Ephemera gutulatta	2
Isonychia sp.	10
Leptophlebia sp.	5
Pseudocloeon sp.	4
Tricorythodes sp.	1
Stenonema ares	3
S. interpunctatum	36
S. tripunctatum	14
S. nepotellum	70
S. bipunctatum	40
ODONATA	
Gomphidae	1
HEMIPTERA	
NEUROPTERA	
MEGALOPTERA	
Sialis sp.	2

TRICOPTERA	
Cheumatopsyche sp.	260
Hydropsyche bifida	180
Hydropsychid genus A	7
Psychomyia sp.	2
Helicopsyche sp.	1
LEPIDOPTERA	
COLEOPTERA	
Optioservus sp. (L)	70
O. sp. (A)	82
Stenelmis sp. (L)	4
DIPTERA	
Hexatoma sp.	14
Chrysops sp.	10
Tendipedidae	300
Simulidae	16
MISCELLANEOUS	

REMARKS:

BENTHOS ANALYSIS

STREAM Spring River STATION S-2 DATE 9-14-64

NUMBER OF ORGANISMS 272 TAXA 20 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	1
Hirudinea	40

MOLLUSCA

Gastropoda

Ferrissia sp.	16

Pelecypoda

Sphaerium sp.	12

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Lirceus sp.	5

Decapoda

Orconectes sp.	4
Immature	6

INSECTA
PLECOPTERA

EPHEMEROPTERA

Ephemera guttulata	7
Paraleptophlebia praepedita	1
Choroterpes sp.	8
Caenis sp.	20
Baetis sp.	15
Heptagenia sp.	7
Stenonema inter-	22
punctatum	22
S. pulchellum	2

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

Hydropsyche bifida	1

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	1

DIPTERA

Hemerodromia sp.	1
Simulium sp.	1
Eriocera sp.	35
Tendipedidae	45

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Spring River STATION S-2 DATE 12-15-64

NUMBER OF ORGANISMS 59 TAXA 13 DIVERSITY

PLATYHELMINTHES

ANNELIDA

MOLLUSCA

Gastropoda

Goniobasis sp.	1

Pelecypoda

Sphaerium sp.	1

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

Isoperla duplicata	1
Branchyptera fasciata	1

EPHEMEROPTERA

Isonychia sp.	7
Stenonema ares	1
S. interpunctatum	8
S. tripunctatum	2
S. bipunctatum	1

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

Optioservus sp. (L)	9
Stenelmis sp. (A)	1

DIPTERA

Silulium sp.	1
Tendipedidae	25

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Spring R. STATION S-2 DATE 3-10-65

NUMBER OF ORGANISMS 1340 TAXA 21 DIVERSITY

PLATYHELMINTHES

Planaria	24

ANNELIDA

Oligochaeta	4
Hirudinea	1

MOLLUSCA

Gastropoda

Goniobasis sp.	1
Ferrissia sp.	49

Pelecypoda

Psidium sp.	3
Sphaerium sp.	12

CRUSTACEA

Phyllopoda

Amphipoda

Stygobromus sp.	10

Isopoda

Decapoda

Orconectes sp.	1

INSECTA

PLECOPTERA

EPHEMEROPTERA

Stenonema ares	3
Caenis sp.	7
Ephemera guttulata	5
Pseudocloeon sp.	34

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

Stenelmis sp. (L)	4
Optioservus sp. (L)	10
Psephenus sp. (L)	1

DIPTERA

Tabanus sp.	1
Chrysops sp.	63
Tendipedidae	1100
Simulidae	3
Culicoides sp.	4

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Spring River STATION S-2 DATE 5-31-65

NUMBER OF ORGANISMS 1434 TAXA 40 DIVERSITY

PLATYHELMINTHES

Planaria	14
Nematoda	5

ANNELIDA

Oligochaeta	20

MOLLUSCA

Gastropoda

Goniobasis sp.	2
Ferrissia sp.	10

Pelecypoda

Sphaerium sp.	3

CRUSTACEA

Phyllopoda

Amphipoda

Allocrangonyx sp.	1

Isopoda

Lirceus sp.	6
Asellus sp.	1

Decapoda

Orconects sp.	5

INSECTA

PLECOPTERA

Perlidae	2

EPHEMEROPTERA

Isonychia sp.	2
Paraleptophlebia sp.	6
Pseudocloeon sp.	5
Baetis sp.	40
Heptagenia sp.	4
Caenis sp.	10
Tricorythodes sp.	8
Leptophlebia sp.	1
Stenonema ares	13
S. interpunctatum	7
S. tripunctatum	4
S. bipunctatum	6
S. pulchellum	3
Ephemera varia	5

ODONATA

Gomphidae	5

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Sialis sp.	1

TRICOPTERA

Helicopsyche sp.	2
Chimarra aterrima	4
Hydropsyche bifida	16
Cheumatopsyche sp.	15

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	4
Stenelmis sp. (L)	6
S. sp. (A)	1
Optioservus sp. (L)	54
O. sp. (A)	180

DIPTERA

Tabanus sp.	2
Hexatoma sp.	41
Simulidae	120
Tendipedidae	800

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Spring River STATION S-3 DATE 9-14-64

NUMBER OF ORGANISMS 270 TAXA 30 DIVERSITY

PLATYHELMINTHES

Planaria	1

ANNELIDA

Oligochaeta	1

MOLLUSCA

Gastropoda

Goniobasis sp.	10
Amnicola sp.	2
Ferrissia sp.	3

Pelecypoda

Sphaerium sp.	25

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes nana	8

INSECTA
PLECOPTERA

EPHEMEROPTERA

Caenis sp.	40
Tricorythodes sp.	3
Isonychia sp.	7
Choroterpes sp.	10
Baetis sp.	40
Heptagenia sp.	10
Stenonema sp. (im.)	5
S. interpunctatum	3
S. pulchellum	7
S. nepotellum	9

ODONATA

Argia sp. (im.)	3

HEMIPTERA

NEUROPTERA

Corydalus cornutus	20

MEGALOPTERA

TRICOPTERA

Limniphilis sp.	3
Hydropsyche bifida	5
Cheumatopsyche sp.	8
Chimarra obscura	2
Empty cases	4

LEPIDOPTERA

COLEOPTERA

Psephenus sp.	13
Optioservus sp. (L)	4
O. sp. (A)	1
Stenelmis sp. (L)	2
S. sp. (A)	3

DIPTERA

Tendipedidae	12
Hemerodromia sp.	1
Eriocera sp.	4
Chrysops sp.	1
Simulium sp.	

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Spring River STATION S-3 DATE 12-15-64

NUMBER OF ORGANISMS 517 TAXA 26 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	5

MOLLUSCA

Gastropoda

Goniobasis sp.	6
Ferrissia sp.	26

Pelecypoda

Sphaerium sp.	90

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	2

INSECTA

PLECOPTERA

Allocapnia sp.	3
Hydroperla sp.	5

EPHEMEROPTERA

Stenonema tripunctatum	29
S. gildersleevei	1
Isonychia sp.	116
Ephemera simulans	11

ODONATA

Argia sp.	1

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corndalus cornutus	7

TRICOPTERA

Cheumatopsyche sp.	47
Hydropsyche bifida	14
Chimarra feria	1
Polycentropus sp.	3

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	6
Stenelmis sp. (L)	5
Optioservus sp.	1
O. sp. (L)	26

DIPTERA

Tipula sp.	10
Simulium sp.	24
Chrysops sp.	3
Eriocera sp.	4
Tendipedidae	70

MISCELLANEOUS

Collembola	1

REMARKS:

BENTHOS ANALYSIS

STREAM Spring R. STATION S-3 DATE 3-10-65

NUMBER OF ORGANISMS 525 TAXA 23 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	29

MOLLUSCA

Gastropoda

Goniobasis sp.	12
Ferrissia sp.	43

Pelecypoda

Sphaerium sp.	116

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes punctimanus	1

INSECTA

PLECOPTERA

Hydroperla sp.	2
Acroneuria arida	1
Perlesta placida	1

EPHEMEROPTERA

Isonychia sp.	12
Caenis sp.	11
Eplimera guttulata	10
Potomanthus sp.	5
Stenonema ares	58
Stenonema interpunctatum	113

ODONATA

Argia sp.	2

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus corydalus	5
Sialis sp.	1

TRICOPTERA

Cheumatopsyche sp.	3
Psychomyia Genus A	1
Helicopsyche borealis	3

LEPIDOPTERA

Cataclysta sp.	1

COLEOPTERA

Psephenus sp.	33
Stenelmis sp. (L)	6
Stenelmis sp. (A)	3
Optioservus sp. (L)	51
Optioservus sp. (A)	2

DIPTERA

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Spring River STATION S-3 DATE 5-31-65

NUMBER OF ORGANISMS 614 TAXA 35 DIVERSITY

PLATYHELMINTHES

Planaria	2

ANNELIDA

Oligochaeta	15
Hirudinea	1

MOLLUSCA

Gastropoda

Goniobasis sp	6
Physa sp.	2
Ferrissia sp.	25

Pelecypoda

Psidium sp.	25
Sphaerium sp	3

CRUSTACEA

Phyllopoda

Amphipoda

Hyallella azteca	1

Isopoda

Lirceus sp	16

Decapoda

Orconectes sp.	42

INSECTA

PLECOPTERA

EPHEMEROPTERA

Isonychia sp.	17
Heptagenia sp	50
Tricorythodes sp.	9
Caenis sp.	32
Baetis sp.	92
Choroterpes sp	8
Pseudocloeon sp	7
Stenonema pulchellum	3
S. interpunctatum	33
S. tripunctatum	3

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

Hydropsyche bifida	2
Cheumatopsyche sp.	21
Helicopsyche sp.	2
Neophylax sp.	5

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	7
Optioservus sp. (L)	16
O. sp. (A)	4
Stenelmis sp. (L)	28
S. sp. (A)	6

DIPTERA

Simulidae	2
Tendipedidae	105
Hexatoma sp.	17
Tabanus sp.	1

MISCELLANEOUS

Nematoda	6

REMARKS:

BENTHOS ANALYSIS

STREAM Honey Creek STATION Sh-1 DATE 9-17-64

NUMBER OF ORGANISMS 138 TAXA 18 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	2

MOLLUSCA

Gastropoda

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

EPHEMEROPTERA

Baetis sp.	25
Choroterpes sp.	28
Caenis sp.	3
Stenonema ares	4
S. interpunctatum	8
S. tripunctatum	3
S. pulchellum	2
Heptagenia flaresence	5
Isonychia sp.	1
Heptagenia lucidipennis	1
Centroptilum sp.	9

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

Oecetis eddlestoni	1

LEPIDOPTERA

COLEOPTERA

DIPTERA

Tendipedidae	25
Simulium sp. (L)	3
Chrysops sp.	8
Hemerodromia sp.	1

MISCELLANEOUS

Nematomorpha	10

REMARKS:

BENTHOS ANALYSIS

STREAM Honey Creek STATION Sh-1 DATE 12-16-64

NUMBER OF ORGANISMS 64 TAXA 8 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	40

MOLLUSCA

Gastropoda

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes luteus	1

INSECTA

PLECOPTERA

Immature	2

EPHEMEROPTERA

Stenonema tripunctatum	1

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

Cheumatopsyche sp.	2

LEPIDOPTERA

COLEOPTERA

Stenelmis sp. (L)	2

DIPTERA

Tendipedidae	3
Chrysops sp.	13

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Honey Cr. STATION Sh-1 DATE 3-16-65

NUMBER OF ORGANISMS 1096 TAXA 9 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	50

MOLLUSCA

Gastropoda

Physa sp.	37

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

Allocapnia sp.	2

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

Hydaticus sp. (L)	1
Stenelmis sp. (L)	1
Optioservus sp. (L)	1

DIPTERA

Chrysops sp.	2
Tendipedidae	1000
Simulidae	2

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Honey Cr. STATION Sh-1 DATE 5-31-65

NUMBER OF ORGANISMS 109 TAXA 16 DIVERSITY

PLATYHELMINTHES	
Nematoda	3
ANNELIDA	
Oligochaeta	1
MOLLUSCA	
Gastropoda	
Physa sp.	9
Pelecypoda	
CRUSTACEA	
Phyllopoda	
Amphipoda	
Isopoda	
Decapoda	
INSECTA	
PLECOPTERA	
Perlesta placida	1
Neoperla clymene	1

EPHEMEROPTERA	
Stenonema interpunctatum	6
Caenis sp.	1
Baetis sp.	22
Pseudocloeon sp.	3
ODONATA	
HEMIPTERA	
NEUROPTERA	
MEGALOPTERA	

TRICOPTERA	
Cheumatopsyche sp.	2
LEPIDOPTERA	
COLEOPTERA	
Stenelmis sp. (L)	5
S. sp. (A)	5
Optioservus sp. (A)	1
O. sp. (L)	3
DIPTERA	
Tendipedidae	50
Chrysops sp.	1
Tipula sp.	1
MISCELLANEOUS	

REMARKS:

BENTHOS ANALYSIS

STREAM Williams Creek STATION Sw-1 DATE 9-17-64

NUMBER OF ORGANISMS 541 TAXA 8 DIVERSITY

PLATYHELMINTHES

Planaria	8

ANNELIDA

Oligochaeta	7
Hirudinea (2 spp.)	13

MOLLUSCA

Gastropoda

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Hyalella azteca	1

Isopoda

Decapoda

INSECTA

PLECOPTERA

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

Stenelmis sp. (A)	2

DIPTERA

Tendipedidae	500
Simulium sp.	8

MISCELLANEOUS

Cladocera	2

REMARKS:

BENTHOS ANALYSIS

STREAM Williams Creek STATION Sw-1 DATE 12-15-64

NUMBER OF ORGANISMS 208 TAXA 5 DIVERSITY

PLATYHELMINTHES

Planaria	150

ANNELIDA

Oligocaheta	40
Hirudinea	9

MOLLUSCA

Gastropoda

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

DIPTERA

Tendipedidae	5
Simulium sp.	4

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Williams Cr. STATION Sw-1 DATE 3-10-65

NUMBER OF ORGANISMS 313 TAXA 7 DIVERSITY

PLATYHELMINTHES

Planariidae	48

ANNELIDA

Oligochaeta	72
Hirudinea	8

MOLLUSCA

Gastropoda

Helisoma sp.	4

Pelecypoda

Sphaerium sp.	1

CRUSTACEA

Phyllopoda

Amphipoda

Gammarus sp.	1

Isopoda

Decapoda

INSECTA

PLECOPTERA

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

DIPTERA

Tendipedidae	179

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Spring River STATION S-4 DATE 9-15-64

NUMBER OF ORGANISMS 282 TAXA 22 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	4
Hirudinea	3

MOLLUSCA

Gastropoda

Coniobasis sp.	70
Ferrissia sp.	

Pelecypoda

Sphaerium sp.	12

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Immature	8

INSECTA

PLECOPTERA

Acroneuria arida	1

EPHEMEROPTERA

Caenis sp.	20
Tricorythodes sp.	65
Ephemera guttulata	4
Heptagenia species B	8
Paraleptophlebia sp.	1
Choroterpes sp.	6
Baetis sp.	25
Stenonema ares	12
S. interpunctatum	9
S. nepotellum	5
S. tripunctatum	4

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	1
Optioservus sp. (L)	2
Stenelmis sp. (A)	2
S. sp. (L)	5

DIPTERA

Tendipedidae	15

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Williams Cr. STATION Sw-1 DATE 5-31-65

NUMBER OF ORGANISMS 947 TAXA 10 DIVERSITY

PLATYHELMINTHES

Planaria	100

ANNELIDA

Oligochaeta	100
Hirudinea	200

MOLLUSCA

Gastropoda

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Crangonyx sp.	1

Isopoda

Lirceus sp.	1

Decapoda

Immature	1

INSECTA

PLECOPTERA

EPHEMEROPTERA

Baetis sp.	2

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

Optioservus sp. (L)	2

DIPTERA

Tendipedidae	500
Simulium sp.	40

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Spring River

STATION S-4

DATE 12-16-64

NUMBER OF ORGANISMS 891

TAXA 30

DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	60
Hirudinea	7

MOLLUSCA

Gastropoda

Amnicola sp.	2
Goniobasis	60
Ferrissia	10
Hydrobia sp.	1

Pelecypoda

Psidium sp.	21
Sphaerium sp.	25

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	6

INSECTA

PLECOPTERA

Taeniopteryx parvula	4

EPHEMEROPTERA

Leptophelebia sp.	1
Hexagenia limbata	1
Ephemera guttulata	3
Ephemeridae	2
Isonychia sp.	7
Caenis sp.	44
Stenonema ares	133
S. nepotellum	42
S. interpunctatum	109
S. tripunctatum	4
Ameletus ludens (Baetidae)	4

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	1

TRICOPTERA

Cheumatopsyche sp.	12
Psychomyia flavida	1

LEPIDOPTERA

COLEOPTERA

Helodidae (A)	1
Optioservus sp. (L)	66
Pseplunus sp. (L)	2
Stenelmis sp. (L)	5
S. sp. (A)	2

DIPTERA

Tendipedidae	253
Simulidae	2

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Spring River STATION S-4 DATE 3-10-65

NUMBER OF ORGANISMS 1902 TAXA 34 DIVERSITY

PLATYHELMINTHES

Planaria	2
Nematoda	4

ANNELIDA

Oligochaeta	145
Hirudinea	9

MOLLUSCA

Gastropoda

Goniobasis sp.	36
Amnicola sp.	3
Ferrissia sp.	11

Pelecypoda

Sphaerium sp.	29

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Lirceus sp.	12

Decapoda

Orconectes sp.	10

INSECTA
PLECOPTERA

EPHEMEROPTERA

Caenis sp.	200
Hexagenia limbata	1
Neocloeon sp.	28
Isonychia sp.	4
Ephemera guttulata	5
Stenonema ares	115
S. nepotellum	47
S. tripunctatum	34
S. interpunctatum	300

ODONATA

Ophiogomphus sp.	2
Gomphidae	2

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

Psychomyia flavida	1
Psychomyiid genus (A)	2
Hydroptila sp.	2
Neureclipsis sp.	1
Cheumatopsyche sp.	1

LEPIDOPTERA

Cataclysta sp.	1

COLEOPTERA

Psephenus sp.	10
Stenelmis sp. (L)	23
S. sp. (A)	5
Optioservus sp. (L)	149
O. sp. (A)	2

DIPTERA

Chrysops sp.	2
Tendipedidae	700
Simulidae	3
Atherix variegata	1

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Spring R. STATION S-4 DATE 6-1-65

NUMBER OF ORGANISMS 623 TAXA 28 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	125
Hirudinea	15

MOLLUSCA

Gastropoda

Somatogyrus sp.	3
Amnicola sp.	1
Goniobasis sp.	20
Ferrissia sp.	6

Pelecypoda

Psidium sp.	6
Sphaerium sp.	5

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Lirceus sp.	12

Decapoda

Orconectes eupunctus	5
O. sp	27

INSECTA

PLECOPTERA

EPHEMEROPTERA

Caenis sp.	16
Potamanthus sp.	6
Baetis sp.	20
Heptagenia sp.	14
Ephemerella bicolor	1
Stenonema ares	2
S. interpunctatum	125
S. bipunctatum	1
S. nepotellum	6

ODONATA

Gomphidae sp.	3

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	13
Optioservus sp. (L)	65
O. sp. (A)	12
Stenelmis sp. (L)	30
S. sp. (A)	8

DIPTERA

Tendipedidae	75

MISCELLANEOUS

Nematoda	1

REMARKS:

BENTHOS ANALYSIS

STREAM Spring River STATION S-5 DATE 9-15-64

NUMBER OF ORGANISMS 515 TAXA 26 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	5
Hirudinea	1

MOLLUSCA

Gastropoda

Goniobasis sp.	25
Ferrissia sp.	4

Pelecypoda

Sphaerium sp.	7

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes nana	10

INSECTA

PLECOPTERA

Neoperla clymene	35

EPHEMEROPTERA

Ephemera guttulata	30
Potomanthus sp.	4
Isonychia sp.	12
Stenonema ares	15
S. interpunctatum	10
S. bipunctatum	35
S. sp. (im.)	60
Caenis sp.	5
Tricorythodes sp.	45
Baetis sp.	40
Heptagenia sp.	25

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	25

TRICOPTERA

Limniphlius sp	11
Chimarra obscura	1
Cheumatopsyche sp	4
Empty cases	2

LEPIDOPTERA

COLEOPTERA

Stenelmis sp. (A)	9
S. sp. (L)	40
Psephenus sp. (L)	30

DIPTERA

Tendipedidae	20
Eriocera sp.	2
Simulium sp.	3

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Spring River STATION S-5 DATE 12-16-64

NUMBER OF ORGANISMS 1,575 TAXA 36 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	140
Hirudinea	1

MOLLUSCA

Gastropoda

Ferrissia sp.	30
Goniobasis	30
Helisoma sp.	1

Pelecypoda

Sphaerium sp.	100

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	5

INSECTA

PLECOPTERA

Neoperla clymene	50
Neophasgonophora capitata	2
Isoperla clio	2
I. duplicata	6
Taeniopteryx nivalis	5
Allocapnia sp.	60

EPHEMEROPTERA

Stenonema ares	12
S. nepotellum	393
S. tripunctatum	3
S. gildersleevei	30
Ephemera simulans	82
Leptophlebia sp.	1
Isonychia sp.	119
Potomanthus sp.	1
Caenis sp.	3

ODONATA

Gomphidae (im.)	3
Argia sp.	1

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Sialis sp.	2
Corydalus cornutus	17

TRICOPTERA

Hydropsyche sp.	7
Cheumatopsyche sp.	60
Agapetus illini	1
Empty cases	4

LEPIDOPTERA

Cataclysta sp.	1

COLEOPTERA

Stenelmis sp. (L)	16
S. sp. (A)	6
Optioservus sp. (L)	35
O. sp. (A)	2
Psephenus sp. (L)	17

DIPTERA

Tendipedidae	300
Simulium sp.	25
Eriocera sp.	2

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Spring R. STATION S-5 DATE 3-9-65

NUMBER OF ORGANISMS 2124 TAXA 42 DIVERSITY

PLATYHELMINTHES

Planaria	

ANNELIDA

Oligochaeta	40
Hirudinea	1

MOLLUSCA

Gastropoda

Ferrissia sp.	25
Goniobasis sp.	40

Pelecypoda

Sphaerium sp.	150

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Lirceus sp.	2

Decapoda

Orconectes nana	7

INSECTA

PLECOPTERA

Isoperla richardsoni	15
Allocapnia sp.	2
Branchyptera fasciata	1
Perlesta placida	2
Neoperla clymene	40
Hydroperla nalata	4

EPHEMEROPTERA

Tricorythodes sp.	11
Caenis sp.	7
Isonychia sp.	23
Potomanthus sp.	8
Ephemera simulans	38
Leptophlebia sp.	1
Heptagenia sp.	15
Stenonema sp.	60
S. tripunctatum	17
S. pulchellum	55
S. interpunctatum	27
S. nepotellum	50
S. ares	24

ODONATA

Gomphidae	1

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	17

TRICOPTERA

Neureclipsis sp.	1
Neophylax sp.	3
Limnephilus consocius	1
Agraylea multipunctata	250
Cheumatopsyche sp.	70
Rhyacophila lobifara	2
Chimarra obscura	4
Psychomyiia flavida	1

LEPIDOPTERA

Cataclysta sp.	2

COLEOPTERA

Psephenus sp. (L)	23
Stenelmis sp. (A)	11
Stenelmis sp. (L)	40
Optioservus sp. (L)	28

DIPTERA

Hexatoma sp.	4
Tendipedidae	1000

MISCELLANEOUS

Acari	1

REMARKS:

BENTHOS ANALYSIS

STREAM Spring R.
STATION S-5
DATE 6-1-65

NUMBER OF ORGANISMS 454
TAXA 34
DIVERSITY

PLATYHELMINTHES

Planaria	1

ANNELIDA

Oligochaeta	9
Hirudinea	10

MOLLUSCA

Gastropoda

Lymnaea sp.	1
Goniobasis sp.	12
Ferrissia sp.	6

Pelecypoda

Sphaerium sp.	60

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Lirceus sp.	1

Decapoda

Orconectes nana	32

INSECTA

PLECOPTERA

Neoperla clymene	17
Hydroperla crosbyi	10

EPHEMEROPTERA

Paraleptophlebia praepedita	1
Potomanthus sp.	50
Ephemera simulans	3
Caenis sp.	2
Isonychia sp.	3
Baetis sp.	21
Heptagenia sp.	35
Stenonema ares	22
S. Interpunctatum	11
S. tripunctatum	7
S. pulchellum	30
S. nepotellum	14

ODONATA

Ophiogomphus sp.	2

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	24

TRICOPTERA

Cheumatopsyche sp.	3

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	2
Stenelmis sp. (L)	22
Stenelmis sp. (A)	8
Optioservus sp. (L)	8
Optioservus sp. (A)	5

DIPTERA

Hexatoma sp.	1
Tipulidae	1
Hemerodromia sp.	1
Tendipedidae	20

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Spring River STATION S-6 DATE 9-15-64

NUMBER OF ORGANISMS 718 TAXA 22 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	7
Hirudinea (2 spp.)	12

MOLLUSCA

Gastropoda

Goniobasis sp.	200
Ferrissia sp.	90
Amnicola sp.	5
Pleuricera sp.	25

Pelecypoda

Sphaerium sp.	80

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Lirceus sp.	1

Decapoda

Orconectes sp.	5

INSECTA

PLECOPTERA

Neoperla clymene	1

EPHEMEROPTERA

Ephemera guttulata	1
Caenis sp.	2
Tricorythodes sp.	35
Baetis sp.	30
Stenonema ares	13
S. nepotellum	25
S. interpunctatum	35
S. bipunctatum	4
Heptagenia sp.	7

ODONATA

HEMIPTERA

NEUROPTERA

Sisyra sp. (near)	10

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

Stenelmis sp. (A)	45
S. (L)	15

DIPTERA

Tendipedidae	70

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Spring River **STATION** S-6 **DATE** 3-9-65

NUMBER OF ORGANISMS 1278 **TAXA** 22 **DIVERSITY**

PLATYHELMINTHES

Planaria	5

ANNELIDA

Oligochaeta	80
Hirudinea	31

MOLLUSCA

Gastropoda

Goniobasis sp.	250
Physa sp.	1
Ferrissia sp.	150
Amnicola sp.	3
Helisoma sp.	1

Pelecypoda

Sphaerium sp	160

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	1

INSECTA

PLECOPTERA

EPHEMEROPTERA

Caenis sp.	9
Tricorythodes sp.	13
Stenonema interpunctatum	16
S. bipunctatum	1
S. nepotellum	8

ODONATA

Argia sp.	13

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

Optioservus sp. (L)	10
Stenelmis sp. (L)	40
S. sp. (A)	17
Dubiraphia sp. (L)	2

DIPTERA

Tendipedidae	600
Tipulidae	1

MISCELLANEOUS

Acari	1

REMARKS:

BENTHOS ANALYSIS

STREAM Spring River STATION S-6 DATE 12-17-64

NUMBER OF ORGANISMS 1,999 TAXA 29 DIVERSITY

PLATYHELMINTHES

Planaria	15

ANNELIDA

Oligochaeta	500
Hirudinea	40

MOLLUSCA

Gastropoda

Goniobasis sp.	600
Helisoma sp.	1
Amnicola sp.	7
Physa sp.	2
Ferrissia sp.	150

Pelecypoda

Sphaerium sp.	200

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp. (im)	2

INSECTA

PLECOPTERA

Nemoura sp.	2

EPHEMEROPTERA

Tricorythodes sp.	90
Caenis sp.	3
Stenonema ares	7
S. interpunctatum	4
S. tripunctatum	30
S. bipunctatum	25

ODONATA

Argia sp.	27
Gomphidae (im.)	1

HEMIPTERA

NEUROPTERA

Sisyra sp.	1

MEGALOPTERA

Corydalus cornutus	1

TRICOPTERA

Cheumatopsyche sp.	1

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	1
Stenelmis sp. (L)	80
S. sp. (A)	35
Dubiraphia sp. (L)	4
Berosus sp. (L)	2
Optioservus sp. (L)	17

DIPTERA

Tendipedidae	150
Tipulidae (im.)	1

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Spring River STATION S-6 DATE 6-1-65

NUMBER OF ORGANISMS Sample lost TAXA ______ DIVERSITY ______

PLATYHELMINTHES

ANNELIDA

MOLLUSCA
Gastropoda

Pelecypoda

CRUSTACEA
Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA
PLECOPTERA

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

DIPTERA

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Spring River STATION S-7 DATE 9-15-64

NUMBER OF ORGANISMS 1070 TAXA 25 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	3
Hirudinea	44

MOLLUSCA

Gastropoda

Goniobasis sp.	550
Ferrissia sp.	60
Amnicola sp.	15
Helisoma sp.	4

Pelecypoda

Sphaerium sp.	80

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Lirceus sp.	1

Decapoda

Orconectes sp.	5

INSECTA
PLECOPTERA

EPHEMEROPTERA

Caenis sp.	4
Tricorythodes sp.	80
Potomanthus sp.	1
Choroterpes sp.	22
Baetis sp.	21
Stenonema ares	20
S. interpunctatum	13
S. bipunctatum	9
S. nepotellum	7
Heptagenia sp.	14

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	8

TRICOPTERA

Helicopsyche sp.	2

LEPIDOPTERA

Cataclysta sp.	2

COLEOPTERA

Psephenus sp. (L)	10
Stenelmis sp. (A)	12
S. sp. (L)	70

DIPTERA

Tendipedidae	13

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Spring River STATION S-7 DATE 12-17-64

NUMBER OF ORGANISMS 1,923 TAXA 29 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	200
Hirudinea	21

MOLLUSCA

Gastropoda

Goniobasis sp.	300
Ferrissia sp.	60
Amnicola sp.	9

Pelecypoda

Sphaerium sp.	200

CRUSTACEA

Phyllopoda

Amphipoda

Hyalella azteca	1

Isopoda

Decapoda

Orconectes sp.	2

INSECTA

PLECOPTERA

Hydroperla harti	1

EPHEMEROPTERA

Isonychia sp	7
Tricorythodes sp	25
Stenonema ares	150
S. nepotellum	150
S. bipunctatum	150
S. tripunctatum	100
S. interpunctatum	250
Heptagenia sp	20

ODONATA

Agrionidae (im.)	6
Gomphidae (im.)	1

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	9

TRICOPTERA

Cheumatopsyche sp.	1
Heliopsyche sp.	1
Chimarra obscura	1
Empty cases	1

LEPIDOPTERA

COLEOPTERA

Stenelmis sp. (A)	50
S. sp. (L)	90
Psephenus sp. (L)	55
Optioservus sp. (L)	4

DIPTERA

Simulium sp.	25
Anthomyiidae	3
Tendipedidae	30

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Spring R. STATION S-7 DATE 3-15-65

NUMBER OF ORGANISMS 516 TAXA 20 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	60
Hirudinea	1

MOLLUSCA

Gastropoda

Goniobasis sp.	160
Amnicola sp.	110
Ferrissia sp.	12

Pelecypoda

Sphaerium sp.	18

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	1

INSECTA

PLECOPTERA

EPHEMEROPTERA

Hexagenia limbata	2
Caenis sp.	4
Stenonema gildersleevei	19
S. pulchellum	4
S. bipunctatum	2
S. ares	3

ODONATA

Argia sp.	2

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	1

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

Psephenus sp.(L)	2
Dubiraphia sp. (L)	4
Stenelmis sp. (A)	2
Stenelmis sp. (L)	6

DIPTERA

Tendipedidae	100
Simulium sp.	3

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Spring R. STATION S-7 DATE 6-1-65

NUMBER OF ORGANISMS 821 TAXA 26 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Hirudinea	7

MOLLUSCA

Gastropoda

Goniobasis sp.	250
Ferrissia sp.	12
Amnicola sp.	40
Lymnaea sp.	1

Pelecypoda

Sphaerium sp.	19

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	6
immature	24

INSECTA

PLECOPTERA

Neoperla clymene	2

EPHEMEROPTERA

Ephoron album	15
Tricorythodes sp.	22
Baetis sp.	7
Stenonema ares	16
S. interpunctatum	100
S. bipunctatum	70
S. nepotellum	20
Heptagenia sp.	40

ODONATA

Argia sp.	11

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	5

TRICOPTERA

Cheumatopsyche sp.	3

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	11
Stenelmis sp. (L)	20
Stenelmis sp. (A)	75
Optioservus sp. (L)	4

DIPTERA

Atherix sp.	1
Tendipedidae	40

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Spring River STATION S-8 DATE 9-15-64

NUMBER OF ORGANISMS 514 TAXA 24 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	3

MOLLUSCA

Gastropoda

Goniobasis sp.	100
Ferrissia sp.	2
Physa sp.	2

Pelecypoda

Sphaerium sp.	75

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	6

INSECTA

PLECOPTERA

Neoperla clymene	1

EPHEMEROPTERA

Tricorythodes sp.	20
Isonychia sp.	40
Chorterpes sp.	35
Potomanthus	1
Baetis sp.	90
Stenonema ares	13
S. interpunctatum	10
S. nepotellum	7
S. bipunctatum	3
Heptagenia sp.	17

ODONATA

HEMIPTERA

NEUROPTERA

Sisyra sp.	1

MEGALOPTERA

Cordalus cornutus	26

TRICOPTERA

Cheumatopsyche sp.	9
Hydropsyche orris	1

LEPIDOPTERA

COLEOPTERA

Stenelmis sp. (A)	25
S. sp. (L)	1

DIPTERA

Tendipedidae	25
Hexatoma sp.	1

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Spring River STATION S-8 DATE 12-17-64

NUMBER OF ORGANISMS 3,137 TAXA 28 DIVERSITY

PLATYHELMINTHES

Planaria	15

ANNELIDA

Oligochaeta	50
Hirudinea	3

MOLLUSCA

Gastropoda

Goniobasis sp.	160
Physa sp.	9
Helisoma sp.	1
Somatogyrus sp.	4
Ferrissia sp.	50

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

Allocapnia sp.	6

EPHEMEROPTERA

Tricorythodes sp.	2000
Baetis sp.	25
Isonychia sp.	40
Caenis sp.	12
Stenenema ares	50
S. interpunctatum	16
S. pulchellum	170
S. bipunctatum	90
Potomanthus sp.	16

ODONATA

Argia sp.	50

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	25

TRICOPTERA

Chimarra obscura	1
Cheumatopsyche sp.	12

LEPIDOPTERA

Cataclysta sp.	2

COLEOPTERA

Psephenus sp. (L)	30
Stenelmis sp. (L)	200
S. sp. (A)	25
Berosus sp. (L)	2

DIPTERA

Simulium sp.	23
Tendipedidae	50

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Spring R. STATION S-8 DATE 3-9-65

NUMBER OF ORGANISMS 1807 TAXA 32 DIVERSITY

PLATYHELMINTHES

Planaria	37

ANNELIDA

Hirudinea	21
Oligochaeta	40

MOLLUSCA

Gastropoda

Goniobasis sp.	65
Amnicola sp.	9
Bulimus sp.	1
Helisoma sp.	2
Ferrissia sp.	20

Pelecypoda

Sphaerium sp.	100

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes meeki	3

INSECTA

PLECOPTERA

Hydroperla crosbyi	1
Neoperla clymene	2
Perlesta placida	4
Leuctra claasseni	1

EPHEMEROPTERA

Tricorythodes sp.	200
Caenis sp.	90
Baetis sp.	400
Isonychia sp.	30
Stenonema tripunctatum	100
S. interpunctatum	90
S. bipunctatum	25
S. pulchellum	30

ODONATA

Argia sp.	7
Gomphidae	1

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	5

TRICOPTERA

Cheumatopsyche sp.	3

LEPIDOPTERA

Cataclysta sp.	1

COLEOPTERA

Psephenus sp. (L)	25
Stenelmis sp. (L)	300
Stenelmis sp. (A)	90
Optioservus sp. (L)	14

DIPTERA

Simulium sp.	10
Tendipedidae	80

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Spring River STATION S-8 DATE 6-1-65

NUMBER OF ORGANISMS 651 TAXA 20 DIVERSITY

PLATYHELMINTHES

Planaria	2

ANNELIDA

MOLLUSCA

Gastropoda

Goniobasis sp.	60

Pelecypoda

Sphaerium sp.	4

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes nana	24

INSECTA

PLECOPTERA

Neoperla clymene	
Perlesta placida	

EPHEMEROPTERA

Baetis sp.	30
Tricorythodes sp.	3
Isonychia sp.	4
Stenonema ares	82
S. nepotellum	30
S. tripunctatum	75
Stenonema sp.	30

ODONATA

Argia sp.	6

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	16

TRICOPTERA

Cheumatopsyche sp.	30

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	3
Stenelmis sp. (L)	90
Stenelmis sp. (A)	150
Optioservus sp. (L)	2

DIPTERA

Simulium sp.	1
Tendipedidae	9

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM North Fork Creek STATION Snf-2 DATE 9-16-64

NUMBER OF ORGANISMS 408 TAXA 15 DIVERSITY

PLATYHELMINTHES

Planaria	4

ANNELIDA

Oligochaeta	6
Hirudinea	2

MOLLUSCA

Gastropoda

Helisoma sp.	3

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Hyalelia azteca	7

Isopoda

Decapoda

INSECTA

PLECOPTERA

EPHEMEROPTERA

Baetis sp.	12
Stenonema interpunctatum	75

ODONATA

Argia sp.	12

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

Cheumatopsyche sp.	110
Chimarra obscura	1
Psychomyiid Genus A	1

LEPIDOPTERA

COLEOPTERA

Stenelmis sp. (L)	7
S. sp. (A)	80

DIPTERA

Silulium sp.	7
Tendipedidae	80

MISCELLANEOUS

Acari	1

REMARKS:

BENTHOS ANALYSIS

STREAM North Fork Creek STATION Snf-2 DATE 12-17-64

NUMBER OF ORGANISMS 267 TAXA 11 DIVERSITY

PLATYHELMINTHES

ANNELIDA

MOLLUSCA

Gastropoda

Helisoma sp.	1
Goniobasis sp.	1

Pelecypoda

Sphaerium sp.	39

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	4

INSECTA

PLECOPTERA

EPHEMEROPTERA

Caenis sp.	1

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

Cheumatopsyche sp.	55
Arthripsodes species A	3

LEPIDOPTERA

COLEOPTERA

Dubiraphia sp. (L)	1
Stenelmis sp. (L)	1

DIPTERA

Tendipedidae	160
Culicoides sp.	1

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM North Fork STATION Snf-2 DATE 3-9-65

NUMBER OF ORGANISMS 549 TAXA 22 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	172
Hirudinea	7

MOLLUSCA

Gastropoda

Physa sp.	7
Gryraulus sp.	3

Pelecypoda

Sphaerium	101

CRUSTACEA

Phyllopoda

Amphipoda

Gammarus sp.	2

Isopoda

Lirceus sp.	1

Decapoda

Orconectes punctimanus	1

INSECTA

PLECOPTERA

EPHEMEROPTERA

Caenis sp.	62
Tricorythodes sp.	2
Stenonema interpunctatum	50
S. tripunctatum	7

ODONATA

Argia sp.	2

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

Cheumatopsyche sp.	13
Limnephilidae	2

LEPIDOPTERA

COLEOPTERA

Stenelmis sp. (L)	1
Dubiraphia sp. (L)	1

DIPTERA

Simulium sp.	81
Tendipedidae	20
Ceratopogonidae	12
Culicidae	1

MISCELLANEOUS

Cladacera	1

REMARKS:

BENTHOS ANALYSIS

STREAM North Fork Cr. STATION Snf-2 DATE 8-9-65

NUMBER OF ORGANISMS 1826 TAXA 34 DIVERSITY

PLATYHELMINTHES	
Planariidae	71
ANNELIDA	
Oligochaeta	264
Hirudinea	22
MOLLUSCA	
Gastropoda	
Physa sp.	14
Goniobasis sp.	1
Planorbula sp.	4
Helisoma sp.	4
Pelecypoda	
Sphaerium sp.	200
CRUSTACEA	
Phyllopoda	
Amphipoda	
Gammarus sp.	8
Isopoda	
Lirceus sp.	3
Decapoda	
INSECTA	
PLECOPTERA	

EPHEMEROPTERA	
Tricorythodes sp.	1
Caenis sp.	122
Neocloeon sp.	22
Hexagenia limbata	1
Stenonema femoratum	3
S. interpunctatum	127
S. tripunctatum	3
ODONATA	
Argia sp.	4
Nasiaeshna sp.	1
Dromogemphus sp.	1
Sympetrum sp.	1
HEMIPTERA	
Corixidae	1
Rhagovelia sp.	1
Microvelia sp.	3
NEUROPTERA	
MEGALOPTERA	

TRICOPTERA	
Cheumatopsyche sp.	800
Chimarra obscura	2
Psychomyiid genus A	2
Psychomyiidae	1
LEPIDOPTERA	
COLEOPTERA	
Stenelmis sp. (L)	9
Stenelmis sp. (A)	4
Dubiraphia sp. (L)	1
DIPTERA	
Tendipedidae	122
Simulidae	2
Chrysops sp.	1
MISCELLANEOUS	

REMARKS:

BENTHOS ANALYSIS

STREAM North Fork Creek STATION Snf-3 DATE 9-16-64

NUMBER OF ORGANISMS 186 TAXA 21 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	12

MOLLUSCA

Gastropoda

Amnicola sp.	1
Helisoma sp.	1

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	3

INSECTA

PLECOPTERA

EPHEMEROPTERA

Stenonema sp.	15
S. tripunctatum	45
S. interpunctatum	20
S. nepotellum	5
Heptagenia sp.	3
Baetis sp.	6
Choroterpes sp.	10
Potomanthus sp.	1
Caenis sp.	1
Tricorythodes sp.	8

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	2

TRICOPTERA

Cheumatopsyche sp.	4

LEPIDOPTERA

COLEOPTERA

Tropisternus sp. (A)	1
Stenelmis sp. (L)	4
S. sp. (A)	10
Elsianus sp. (L)	2

DIPTERA

Culicidae	1
Tendipedidae	30
Unidentified	1

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM North Fork Creek STATION Snf-3 DATE 12-17-64

NUMBER OF ORGANISMS 437 TAXA 14 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	91
Hirudinea	4

MOLLUSCA

Gastropoda

Pelecypoda

Sphaerium sp.	39

CRUSTACEA

Phyllopoda

Amphipoda

Gammarus sp.	1

Isopoda

Decapoda

Orconectes sp.	1

INSECTA

PLECOPTERA

EPHEMEROPTERA

Caenis sp.	130
Stenonema nepotellum	1
S. tripunctatum	53
S. interpunctatum	47

ODONATA

Gomphidae (im.)	1

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Sialis sp.	3
Corydalus cornutus	1

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

Stenelmis sp. (L)	15
S. sp. (A)	4

DIPTERA

Tendipedidae	46

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM North Fork Cr.
STATION Snf-3
DATE 3-9-65

NUMBER OF ORGANISMS 409
TAXA 22
DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	35
Hirudinea	2

MOLLUSCA

Gastropoda

Physa sp.	1
Ferrissia sp.	
Helisoma sp.	1
Lymnaea sp.	1

Pelecypoda

Sphaerium sp.	13

CRUSTACEA

Phyllopoda

Amphipoda

Hyalella azteca	1

Isopoda

Decapoda

INSECTA

PLECOPTERA

Isoperla sp.	1
Perlesta sp.	1

EPHEMEROPTERA

Potomanthus sp.	2
Hexagenia sp.	1
Caenis sp.	120
Stenonema interpunctatum	55
S. tripunctatum	90
S. bipunctatum	

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

Leptocella sp.	1

LEPIDOPTERA

COLEOPTERA

Stenelmis sp. (L)	4
Stenelmis sp. (A)	11
Optioservus sp. (L)	2

DIPTERA

Simulium sp.	4
Tendipedidae	60
Culicidae	3

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM North Fork Cr. STATION Snf-3 DATE 8-9-65

NUMBER OF ORGANISMS 128 TAXA 15 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	3

MOLLUSCA

Gastropoda

Pelecypoda

Sphaerium sp.	1

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	6

INSECTA

PLECOPTERA

Acroneuria arida	1

EPHEMEROPTERA

Hexagenia limbata	14
Caenis sp.	1
Stenonema interpunctatum	25
S. tripunctatum	29

ODONATA

Argia sp.	4
Somatochlora sp.	1
Gomphidae	1

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

Cheumatopsyche sp.	3

LEPIDOPTERA

COLEOPTERA

Stenelmis sp. (L)	4
Stenelmis sp. (A)	26

DIPTERA

Tendipedidae	9

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Center Creek STATION Sc-1 DATE 9-1-64

NUMBER OF ORGANISMS 336 TAXA 24 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	3
Hirudinea	3

MOLLUSCA

Gastropoda

Goniobasis sp.	140
Helisoma sp.	1

Pelecypoda

Sphaerium sp.	8

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	1

INSECTA
PLECOPTERA

EPHEMEROPTERA

Caenis sp.	14
Tricorythodes sp.	7
Ephemera guttulata	8
Isonychia sp.	6
Baetis sp.	15
Choroterpes sp.	1
Stenonema interpunctatum	7
S. pulchellum	4
S. nepotellum	9

ODONATA

Hetaerina sp.	2
Gomphidae (im.)	1

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	2

TRICOPTERA

Neophylax sp.	10
Cheumatopsyche sp.	1
Helicopsyche sp.	40

LEPIDOPTERA

Cataclysta sp.	3

COLEOPTERA

Psephenus sp. (L)	40
Optioservus sp. (L)	7
Stenelmis sp. (L)	3

DIPTERA

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Center Creek STATION Sc-1 DATE 11-30-64

NUMBER OF ORGANISMS 1,767 TAXA 46 DIVERSITY

PLATYHELMINTHES	
Planaria	10
ANNELIDA	
Oligochaeta	40
Hirudinea	2
MOLLUSCA	
Gastropoda	
Amnicola sp.	28
Goniobasis sp.	150
Somatogyrus sp.	12
Ferrissia sp.	60
Pelecypoda	
Sphaerium sp.	102
Psidium sp.	43
CRUSTACEA	
Phyllopoda	
Amphipoda	
Gammarus	1
Isopoda	
Decapoda	
Orconectes sp.	6
INSECTA	
PLECOPTERA	
Isoperla duplicata	1
Allocapnia sp.	14
Brachyptera fasciata	1

EPHEMEROPTERA	
Caenis sp.	3
Leptophlebia sp.	1
Stenonema ares	289
S. nepotellum	46
S. interpunctatum	28
Hexagenia lirnbeta	1
Ephemera guttulata	8
Isonychia sp.	83
Ameletus ludens	1
Neocloeon sp.	12
Stenonema tripunctatum	1
Baetis sp.	1
ODONATA	
Calopteryx sp.	2
HEMIPTERA	
NEUROPTERA	
MEGALOPTERA	
Corydalus cornutus	9

TRICOPTERA	
Hydropsyche betteni	2
Glossosoma sp.	1
Neophylax sp.	17
Chimarra atterima	14
Cheumatopsyche sp.	1
Hydropsyche bifida	2
Phylocentropus sp.	82
Helicopsyche sp.	
Empty cases	200
LEPIDOPTERA	
Cataclysta sp.	9
COLEOPTERA	
Psephenus sp. (L)	95
Dubiraphia sp. (L)	2
Optioservus sp. (L)	300
Optioservus sp. (A)	6
Stenelmis sp. (L)	4
Stenelmis sp. (A)	2
DIPTERA	
Simulium sp.	14
Tendipedidae	50
Psychodidae	2
Anthomyiidae	1
MISCELLANEOUS	
Isotomurus sp.	1
Nematoda	7

REMARKS:

BENTHOS ANALYSIS

STREAM Center Cr. STATION Sc-1 DATE 2-16-65

NUMBER OF ORGANISMS 273 TAXA 33 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	22

MOLLUSCA

Gastropoda

Goniobasis sp.	20
Physa sp.	16
Ferrissia sp.	2

Pelecypoda

Psidium sp.	1
Sphaerium sp.	9

CRUSTACEA

Phyllopoda

Amphipoda

Gammarus sp.	2

Isopoda

Decapoda

Orconectes sp.	1

INSECTA

PLECOPTERA

Hydroperla sp.	2

EPHEMEROPTERA

Stenonema nepotellum	5
S. ares	19
S. tripunctatum	2
S. interpunctatum	38
Isonychia sp.	5
Ameletus ludens	1
Ephemera guttulata	12
Caenis sp.	2
Leptophlebia sp.	4

ODONATA

Hetaerina sp.	1
Argia sp.	1
Octogomphus sp.	2

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	1

TRICOPTERA

Hydropsyche orris	1
Hydropsyche bifida	1
Neophylax sp.	2
Helicopsyche sp.	29

LEPIDOPTERA

Cataclysta sp.	2

COLEOPTERA

Psephenus sp. (L)	10
Stenelmis sp. (A)	1
Dubiruphia sp. (L)	6
Optioservus sp. (L)	24

DIPTERA

Tendipedidae	28
Tabanus sp.	1

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Center Cr. STATION Sc-1 DATE 5-12-65

NUMBER OF ORGANISMS 398 TAXA 25 DIVERSITY

PLATYHELMINTHES

Planariidae	2

ANNELIDA

Oligochaeta	7
Hirudinea	4

MOLLUSCA

Gastropoda

Goniobasis sp.	54

Pelecypoda

Sphaerium sp.	2

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	5

INSECTA

PLECOPTERA

Neoperla clymene	1

EPHEMEROPTERA

Neocloeon sp.	90
Stenonema ares	100
S. interpunctatum	9
S. nepotellum	21
Isonychia sp.	12
Caenis sp.	3
Ephemeridae	1

ODONATA

Gomphidae	1
Argia sp.	1

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	4

TRICOPTERA

Cheumatopsyche sp.	3
Helicopsyche sp.	10

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	14
Stenelmis sp. (L)	19
Stenelmis sp. (A)	4
Optioservus sp. (L)	12
Hydrochus sp. (A)	1

DIPTERA

Tendipedidae	18

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Center Creek STATION Sc-2 DATE 9-1-64

NUMBER OF ORGANISMS 288 TAXA 23 DIVERSITY 4.06

PLATYHELMINTHES

ANNELIDA

Oligochaeta	8

MOLLUSCA

Gastropoda

Amnicola sp.	1
Goniobasis sp.	39
Ferrissia sp.	7

Pelecypoda

Sphaerium sp.	50

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	1

INSECTA

PLECOPTERA

Acroneuria arida	2

EPHEMEROPTERA

Isonychia sp.	8
Tricorythodes sp.	9
Caenis sp.	25
Centroptilum sp.	4
Baetis sp.	7
Stenonema sp.	10
S. ares	3
S. nepotellum	5
Ephemera sp.	12

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	13

TRICOPTERA

Cheumatopsyche sp.	3
Heliopsyche sp.	2
Hydropsyche bifida	2

LEPIDOPTERA

COLEOPTERA

Stenelmis sp. (L)	25
S. sp. (A)	1
Optioservus sp. (L)	40

DIPTERA

MISCELLANEOUS

Acari	1

REMARKS:

BENTHOS ANALYSIS

STREAM Center Creek STATION Sc-2 DATE 11-30-64

NUMBER OF ORGANISMS 1,291 TAXA 47 DIVERSITY 3.48

PLATYHELMINTHES

Planaria	1	0

ANNELIDA

Oligochaeta	32	48.2
Hirudinea	4	2.4

MOLLUSCA

Gastropoda

Pyrgulopsis sp.	3	1.4
Amnicola sp.	1	
Goniobasis sp.	120	249.5
Ferrissia sp.	90	175.9

Pelecypoda

Psidium sp.	50	84.9
Sphaerium sp.	2	

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes neglectus	4	2.4

INSECTA

PLECOPTERA

Isoperla duplicata	2	.6
I. confusa	1	
Hydroperla crosbyi	2	.6
Neoperla clymene	4	2.4
Allocapnia sp.	14	16.0
Hydroperla nalata	3	1.4

EPHEMEROPTERA

Ephemera simulans	54	93.5
Isonychia sp.	80	152.2
Potomanthus sp.	7	5.9
Caenis sp.	5	3.5
Tricorythodes sp.	1	
Baetis sp.	8	7.2
Stenonema interpunctatum	40	64.1
S. nepotellum	100	200
S. bipunctatum	30	44.3
S. pulchellum	14	16.0
S. ares	12	13.0

ODONATA

Lanthus sp.	2	.6
Gomphidae (im.)	1	

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Chauliodes sp.	2	.6
Corydalus cornutus	14	
Sialis sp.	1	

TRICOPTERA

Chimarra sp. (im.)	1	0
Helicopsyche sp.	55	95.7
Glossosoma sp.	17	20.9
Hydropsyche bifida	43	70.2
Cheumatopsyche sp.	175	392.5
Neophylax sp. cases:	2	

LEPIDOPTERA

Cataclysta sp.	5	

COLEOPTERA

Psephenus sp. (L)	35	
Stenelmis sp. (L)	40	64.1
S. sp. (A)	4	2.4
Optioservus sp. (L)	80	152.2
O. sp. (A)	2	.6
Narpus sp. (L)	2	.6

DIPTERA

Simulium sp.	2	.6
Tendipedidae	50	84.9
Chrysops sp.	1	0

MISCELLANEOUS

Arachnida (Acari)	1	0

REMARKS:

BENTHOS ANALYSIS

STREAM Center Cr. STATION Sc-2 DATE 2-15-65 ✓2

NUMBER OF ORGANISMS 377 TAXA 32 5.23 DIVERSITY 4.22

PLATYHELMINTHES

ANNELIDA

Oligochaeta	17	20.9
Hirudinea	3	1.4

MOLLUSCA

Gastropoda

Ferrissia sp.	28	40.5
Goniobasis sp.	19	24.3
Amnicola sp.	2	.6

Pelecypoda

Psidium sp.	4	2.4
Sphaerium sp.	1	0

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes punctimanus	3	1.4

INSECTA

PLECOPTERA

~~Allocapnia sp.~~	7	5.9
~~Neoperla clymene~~	1	0
~~Hydroperla nalata~~	1	
~~Isoperla richardsoni~~	3	1.4

EPHEMEROPTERA

Ephemera guttulata	24	33.1
Potomanthus sp.	4	2.4
Caenis sp.	7	5.9
Isonychia sp.	9	8.6
Heptagenia sp.	5	3.5
Stenonema ares	12	12.9
S. tripunctatum	5	3.5
S. interpunctatum	10	10
S. nepotellum	7	5.9

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	1	0

TRICOPTERA

Helicopsyche sp.	21	27.8
Glossosoma sp.	2	.6
Hydropsyche bifida	4	2.4
Cheumatopsyche sp.	43	70.2

LEPIDOPTERA

Cataclysta	11	11.4

COLEOPTERA

Optioservus sp. (L)	21	27.8
Psephenus sp. (L)	19	24.3
Stenelmis sp. (L)	12	12.9

DIPTERA

Tendipedidae	70	129.2

MISCELLANEOUS

Acari	1	0

REMARKS:

71.20 — 491.20

4.09 Avg 65

BENTHOS ANALYSIS

STREAM Center Cr. STATION Sc-2 DATE 5-13-65

NUMBER OF ORGANISMS 209 TAXA 36 6.56 DIVERSITY 4.60

PLATYHELMINTHES

ANNELIDA

Oligochaeta	24	33.2
Hirudinea	13	14.5

MOLLUSCA

Gastropoda

Somatogyrus sp.	2	.6
Goniobasis sp.	10	10
Planorbula sp.	1	0

Pelecypoda

Sphaerium sp.	1	0

CRUSTACEA

Phyllopoda

Amphipoda

Gammarus sp.	4	2.4

Isopoda

Decapoda

Orconectes neglectus	2	.6
O. sp.	2	.6

INSECTA

PLECOPTERA

Neoperla clymene	6	4.7
Acroneuria arida	1	0
Perlesta placida	1	0

EPHEMEROPTERA

Stenonema ares	11	11.4
S. interpunctatum	12	12.9
S. tripunctatum	7	5.9
S. nepotellum	7	5.9
Hexagenia limbata	3	1.4
Ephemera guttulata	2	.6
Neocloeon sp.	21	22.8
Caenis sp.	3	1.4

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Sialis sp.	2	.6
Corydalus cornutus	2	.6

TRICOPTERA

Limnephilidae	1	0
Neophylax sp.	4	2.4
Helicopsyche sp.	1	0
Cheumatopsyche sp.	12	12.9
Athriposides species A	1	0

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	7	5.9
Stenelmis sp. (L)	8	7.2
S. sp. (A)	5	3.5
Optioservus sp. (L)	8	7.2
Berosus sp. (L)	1	0

DIPTERA

Tabanus sp.	2	.6
Chrysops sp.	2	.6
Tendipedidae	7	5.9
Simulidae	13	14.5

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Center Creek STATION Sc-3 DATE 9-1-64

NUMBER OF ORGANISMS 203 TAXA 27 DIVERSITY 4.14

PLATYHELMINTHES

ANNELIDA

Oligochaeta	1	0

MOLLUSCA

Gastropoda

Goniobasis sp.	55	95.7

Pelecypoda

Sphaerium sp.	8	7.2

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Immature	3	1.4

INSECTA

PLECOPTERA

Neoperla clymene	3
Acroneuria raralis	1

EPHEMEROPTERA

Isonychia sp.	7	5.9
Tricorythodes sp.	2	.6
Caenis sp.	4	2.4
Pentagenia sp.	8	7.2
Heptagenia maculipennis	3	1.4
Siphlonurus marshalli	1	0
Baetis sp.	3	1.4
Stenonema sp.	12	12.9
S. pulchellum	8	7.2
S. ares	7	5.9
S. nepotellum	13	14.5
S. tripunctatum	2	.6
Baetis vagans	7	5.9
B. levitans	4	2.4

ODONATA

Immature	2	.6

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	13	14.5

TRICOPTERA

Helicopsyche sp	9	8.6
Neophylax	3	1.4
Cheumatopsyche sp	3	1.4

LEPIDOPTERA

COLEOPTERA

Stenelmis sp. (A)	11
S. sp. (L)	4
Optioservus sp.	2

DIPTERA

Tendipedidae	4

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Center Creek STATION Sc-3 DATE 11-30-64

NUMBER OF ORGANISMS 1,298 TAXA 47 DIVERSITY

PLATYHELMINTHES		
Planaria	3	1.4
ANNELIDA		
Oligochaeta	50	84.9
Hirudinea	2	.6
MOLLUSCA		
Gastropoda		
Goniobasis sp.	160	352.7
Ferrissia sp.	80	152.2
Planorbula sp.	3	1.4
Pelecypoda		
Sphaerium sp.	60	106.7
CRUSTACEA		
Phyllopoda		
Amphipoda		
Allocrangonyx pellucides	2	.6
Isopoda		
Decapoda		
Immature	1	0
INSECTA		
PLECOPTERA		
Allocapnia sp.	7	5.9
Neoperla clymene	4	2.4
Acroneuria arida	9	8.6
A. internata	1	0
Taeniopteryx maura	6	4.6
Leuctra classeni	30	44.3

EPHEMEROPTERA		
Ephemera guttulata	190	433
Isonychia sp.	80	152.2
Caenis sp.	25	34.9
Tricorythodes sp.	7	5.9
Baetis sp.	14	16.
Paraleptophelbia sp.	11	11.4
Stenonema nepotellum	80	152.2
S. interpunctatum	170	379.2
ODONATA		
Argia sp.	4	2.4
Comphidae (im.)	2	.6
HEMIPTERA		
NEUROPTERA		
MEGALOPTERA		
Corydalus cornutus	7	5.9
Sialis sp.	2	.6

TRICOPTERA		
Cheumatopsyche sp.	70	129.2
Chimarra obscura	4	2.4
Psilotreta sp.	1	
Helicopsyche sp.	3	1.4
Leptocella sp.	1	0
Neophylax sp.	3	1.4
LEPIDOPTERA		
Cataclysta sp.	1	0
COLEOPTERA		
Psephenus sp.	60	106.7
Stenelmis sp. (L)	60	106.7
S. sp. (A)	16	19.3
Optioservus sp. (L)	7	5.9
Helichus sp. (A)	1	0
DIPTERA		
Sepedon sp.	5	3.5
Eriocera sp.	1	0
Simulium sp.	2	.6
Tendipedidae	50	84.9
~~MISCELLANEOUS~~ Amphiopoda		
Synurella sp.	3	1.4

REMARKS:

BENTHOS ANALYSIS

STREAM Center Creek STATION Sc-3 DATE 2-16-65

NUMBER OF ORGANISMS 1073 TAXA 42 5.88 DIVERSITY 4.07

PLATYHELMINTHES

ANNELIDA
Oligochaeta 23 31.3

MOLLUSCA
Gastropoda
Goniobasis sp. 8 7.2
Ferrissia sp. 6 4.7
Gyraulus sp. 1 0

Pelecypoda
Sphaerium sp. 8 7.2

CRUSTACEA
Phyllopoda

Amphipoda
Crangonyx sp. 17 20.9

Isopoda

Decapoda
Orconectes hylas 1 0

INSECTA
PLECOPTERA
Neoperla clymene 5 3.5
Acroneuria arida 5 3.5
A. interpunctatum 1 0
Neophasgonophora capitata 10 10
Isoperla sp. 2 .6
Branchyptera fasciata 6 4.7
Allocapnia sp. 17 20.9

EPHEMEROPTERA
Isonychia sp. 180 405.9
Baetis sp. 5 3.5
Heptagenia 50 84.9
Ephemera guttulata 40 64.1
Tricorythodes sp. 5 3.5
Caenis sp. 2 .6
Leptophoebia sp. 7 5.9
Stenonema ares 80 152.2
S. interpunctatum 35 54.0
S. pulchellum 13 14.5
S. bipunctatum 50 84.9

ODONATA
Agrionidae 1 0

HEMIPTERA

NEUROPTERA

MEGALOPTERA
Corydalus cornutus 7 5.9

TRICOPTERA
Heliocopsyche sp. 7 5.9
Pycnopsyche sp. 2 .6
Chimarra obscura 3 1.4
Neophylax sp. 4 2.4
Leptocerus sp. 1 0
Cheumatopsyche sp. 200 460.0

LEPIDOPTERA
Cataclysta sp. 4 2.4

COLEOPTERA
Stenelmis sp. (L) 25 34.4
S. sp. (A) 10 10
Optioservus sp. (L) 6 4.7
Psephenus sp. (L) 50 84.9

DIPTERA
Chrysops sp. 1 0
Hexatoma sp. 1 0
Tipula sp. 9 8.6
Tendipedidae sp. 100 200
Simulium sp. 65 117.8

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Center Cr. STATION Sc-3 DATE 5-12-65

NUMBER OF ORGANISMS 694 TAXA 38 5.66 DIVERSITY 4.43

PLATYHELMINTHES

ANNELIDA

Oligochaeta	5	3.5

MOLLUSCA

Gastropoda

Goniobasis sp.	14	16.0
Ferrissia sp.	2	.6
Gyraulus sp.	1	0
Physa	1	0

Pelecypoda

Sphaerium sp.	2	.6

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Lirceus sp.	2	.6

Decapoda

Orconectes sp.	9	8.6

INSECTA

PLECOPTERA

Neoperla clymene	30	44.3
Neophasganophora capitata	17	20.9
Perlesta placida	7	5.9
Acroneuria arida	25	34.9

EPHEMEROPTERA

Rhithrogenia sp.	2	.6
Isonychia sp.	50	84.9
Baetis sp.	110	224.5
Tricorythodes sp.	30	44.3
Heptagenia sp.	25	34.9
Caenis sp.	14	16.0
Ephemera guttulata	7	5.9
Potamanthus sp.	4	2.4
Stenonema ares	13	14.5
S. bipunctatum	50	84.9
S. pulchellum	25	34.9
S. tripunctatum	40	64.1

ODONATA

Libelluidae	6	4.7

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	5	3.5

TRICOPTERA

Helicopsyche sp.	2	.6
Cheumatopsyche sp.	22	29.6

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	40	64.1
Stenelmis sp. (L)	17	20.9
S. sp. (A)	20	26.1
Optioservus sp. (A)	2	.6
O. sp (L)	10	10

DIPTERA

Tabanus sp.	1	0
Chrysops sp.	1	0
Eulalia sp.	1	0
Simulium sp.	12	11.4
Tendipedidae	70	129.2

MISCELLANEOUS

REMARKS:

[illegible]
1044.[illegible]
7.3[illegible]

BENTHOS ANALYSIS

STREAM Center Creek STATION Sc-4 DATE 9-1-64

NUMBER OF ORGANISMS 12 TAXA 4 1.2 DIVERSITY 1.6

PLATYHELMINTHES

ANNELIDA

MOLLUSCA

Gastropoda

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

Acroneuria arida 4 2.4

EPHEMEROPTERA

Stenonema sp. (im.) 1 0

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

Stenelmis sp. (L) 1 0

Berosus sp. (L) 6 4.7

DIPTERA

MISCELLANEOUS

REMARKS:

7.1

BENTHOS ANALYSIS

STREAM Center Creek STATION Sc-4 DATE 12-1-64

NUMBER OF ORGANISMS 20 TAXA 3 .67 DIVERSITY 1.41

PLATYHELMINTHES

ANNELIDA

MOLLUSCA

Gastropoda

Physa sp.	6	4.7

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

Berosus sp. (L)	11	11.4

DIPTERA

Tendipedidae	3	1.4

MISCELLANEOUS

REMARKS:

16 tubes

BENTHOS ANALYSIS

STREAM Center Cr. STATION Sc-4 DATE 2-15-65

NUMBER OF ORGANISMS 8 TAXA 2 .48 DIVERSITY .79

PLATYHELMINTHES

ANNELIDA

MOLLUSCA

Gastropoda

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

Acroneuria arida	2 .6

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

Berosus sp. (L)	6 49

DIPTERA

MISCELLANEOUS

REMARKS:

.415

1.33 Ave 65

BENTHOS ANALYSIS

STREAM Center Cr. STATION Sc-4 DATE 5-12-65

NUMBER OF ORGANISMS 261 TAXA 16 2.70 DIVERSITY 1.52

PLATYHELMINTHES

ANNELIDA

Oligochaeta	4	2.4

MOLLUSCA

Gastropoda

Physa sp.	1	0

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

Perlesta placida	2	.6
Neoperla clymene	3	1.4

EPHEMEROPTERA

Heptagenia sp.	21	27.7
Baetis sp.	1	0
Isonychia sp.	2	.6
Stenonema tripunctatum	1	0
S. interpunctatum	1	0

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	2	.6

TRICOPTERA

Cheumatopsyche sp.	10	

LEPIDOPTERA

COLEOPTERA

Stenelmis sp. (A)	7	5.9
Stenelmis sp. (L)	2	.6
Optioservus sp. (A)	1	

DIPTERA

Tendipedidae	200	460.2
Simulidae	3	1.4

MISCELLANEOUS

REMARKS:

630.7

[illegible]

BENTHOS ANALYSIS

STREAM Center Creek STATION Sc-5 DATE 9-2-64

NUMBER OF ORGANISMS 10 TAXA 2 DIVERSITY .96

PLATYHELMINTHES

ANNELIDA

MOLLUSCA

Gastropoda

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

~~Corydalus cornutus~~	6 4.7

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

Berosus sp.	4 2.4

DIPTERA

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Center Creek STATION Sc-5 DATE 12-1-64

NUMBER OF ORGANISMS 62 [illegible] TAXA 5 DIVERSITY 1.97

PLATYHELMINTHES

ANNELIDA

MOLLUSCA

Gastropoda

Physa sp. 9 8.6

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus 7 5.9

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

Berosus sp. (L) 21 27.8

DIPTERA

Tendipedidae 23 31.2

Simulidae 2 .6

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Center Creek STATION Sc-5 DATE 2-15-65

NUMBER OF ORGANISMS 16 19.3 TAXA 3 .72 DIVERSITY .87

PLATYHELMINTHES

ANNELIDA

MOLLUSCA

Gastropoda

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus 2 .6

TRICOPTERA

Leptoceridae 1 [illegible]

LEPIDOPTERA

COLEOPTERA

Berosus sp. (L) 13 14.5

DIPTERA

MISCELLANEOUS

REMARKS:

[illegible]

15

[illegible]

1.25 [illegible]

BENTHOS ANALYSIS

STREAM Center Cr. STATION Sc-5 DATE 5-12-65

NUMBER OF ORGANISMS 1078 TAXA 15 2.00 DIVERSITY 1.19

PLATYHELMINTHES

ANNELIDA

MOLLUSCA

Gastropoda

Physa sp.	12	13.0
Gyranulus sp.	1	0

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

Isoperla richardsoni	2	.6

EPHEMEROPTERA

Heptagenia sp.	5	3.5
Baetis sp.	2	.6

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	3	1.4

TRICOPTERA

Cheumatopsyche sp.	5	3.5
Psychomyiidae	3	1.4

LEPIDOPTERA

COLEOPTERA

Berosus sp. (L)	23	34.3
Dinetus sp. (L)	5	3.5
D. sp. (A)	2	.6
Stenelmis sp. (L)	1	0

DIPTERA

Tendipedidae	200	460.2
Simulidae	14	16
Ceratopogonidae	800	23225

MISCELLANEOUS

REMARKS:

[illegible]

[illegible]
553.9

BENTHOS ANALYSIS

STREAM Center Creek STATION Sc-6 DATE 9-2-64

NUMBER OF ORGANISMS 56 TAXA 9 DIVERSITY 2.32

PLATYHELMINTHES

ANNELIDA

MOLLUSCA

Gastropoda

Physa sp.	25	34.9
Goniobasis sp.	1	0

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

Acroneuria arida	2	.6

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	6	4.7
Sialis sp.	1	0

TRICOPTERA

Cheumatopsyche sp.	11	11.4
Oecetis sp.	1	0

LEPIDOPTERA

COLEOPTERA

Berosus sp	8	7.2
Dinetus sp	1	0

DIPTERA

MISCELLANEOUS

REMARKS:

DATA LOST

BENTHOS ANALYSIS

STREAM Center Creek STATION Sc-6 DATE 12-1-64

NUMBER OF ORGANISMS Sample lost TAXA DIVERSITY

PLATYHELMINTHES

ANNELIDA

MOLLUSCA

Gastropoda

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

DIPTERA

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Center Creek STATION Sc-6 DATE 2-16-65

NUMBER OF ORGANISMS 338 TAXA 9 1.37 DIVERSITY 1.67

PLATYHELMINTHES

Planaria	4	2.4

ANNELIDA

Oligochaeta	7	5.9

MOLLUSCA

Gastropoda

Physa sp.	200	460.2
Ferrissia sp.	1	0

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

EPHEMEROPTERA

ODONATA

Argia sp.	1	0

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Sialis sp.	3	1.4
Corydalus cornutus	2	.6

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

Berosus sp. (L)	70	129.2

DIPTERA

Tendipedidae	50	24.9

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Center Cr. STATION Sc-6 DATE 5-12-65

NUMBER OF ORGANISMS 346 TAXA 14 2.22 DIVERSITY 1.00

PLATYHELMINTHES

Planaria sp.	9	8.6

ANNELIDA

Oligochaeta	7	5.9
Cocoons of Hirudinea		

MOLLUSCA

Gastropoda

Physa sp.	3	1.4

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

EPHEMEROPTERA

Stenonema sp.	2	.6

ODONATA

HEMIPTERA

NEUROPTERA

Sisyra sp.	1

MEGALOPTERA

Corydalus cornutus	1

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (A)	2	.6
Dinetus sp. (L)	4	2.9
Dinetus sp. (A)	1	0
Berosus sp. (L)	1	0
Hydrochus sp. (L)	1	0
Hydrochus sp. (A)	5	3.5

DIPTERA

Tendipedidae	300	793.1
Simulium sp.	9	8.6

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Center Creek STATION Sc-7 DATE 9-2-64

NUMBER OF ORGANISMS 271 TAXA 9 1.43 DIVERSITY 1.46

PLATYHELMINTHES

ANNELIDA

MOLLUSCA

Gastropoda

Physa sp.	5	8.5

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	4	2.4
Sialis sp.	3	1.4

TRICOPTERA

Hydropsyche simulans	17	20.9
H. frisoni	8	7.2
Cheumatopsyche sp.	30	44.4

LEPIDOPTERA

COLEOPTERA

Berosus sp.	1
Dinetus sp.	1

DIPTERA

Tendipedidae	200	460.2
Chrysops sp.	2	.6

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Center Creek STATION Sc-7 DATE 12-1-64

NUMBER OF ORGANISMS 62 TAXA 9 1.94 DIVERSITY 2.52

PLATYHELMINTHES

ANNELIDA

MOLLUSCA

Gastropoda

Physa sp.	3	1.4
Goniobasis sp.	1	0

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	14	16

TRICOPTERA

Hydropsyche betteni	2	.6

LEPIDOPTERA

COLEOPTERA

Berosus sp. (L)	5	3.5

DIPTERA

Tendipedidae	16	19.3
Hexatoma sp.	2	.6
Psychodidae	1	0
Simulidae	18	22.6

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Center Cr. **STATION** Sc-7 **DATE** 2-16-65

NUMBER OF ORGANISMS 70 **TAXA** 8 1.65 **DIVERSITY** 2.62

PLATYHELMINTHES

ANNELIDA

Oligochaeta	1

MOLLUSCA

Gastropoda

Physa sp.	16 19.3

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	6 4.7

TRICOPTERA

Cheumatopsyche sp.	1

LEPIDOPTERA

COLEOPTERA

Berosus sp. (L)	11

DIPTERA

Simulium sp.	12 12.9
Eriocera sp.	6 4.7
Tendipedidae	17 20.9

MISCELLANEOUS

REMARKS:

1.76

BENTHOS ANALYSIS

STREAM Center Cr. STATION Sc-7 DATE 5-12-65

NUMBER OF ORGANISMS 530 TAXA 8 1.12 DIVERSITY .46

PLATYHELMINTHES

ANNELIDA

Oligochaeta	7	5.9

MOLLUSCA

Gastropoda

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

Perlesta placida	1	0

EPHEMEROPTERA

ODONATA

HEMIPTERA

1-Immature	1	[illegible]

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	6	4.7

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

Dinetus sp. (L)	8	7.2
Dinetus sp. (A)	3	1.4

DIPTERA

Tendipedidae	500	[illegible]
Simulium sp.	4	[illegible]

MISCELLANEOUS

REMARKS:

22.8

BENTHOS ANALYSIS

STREAM Center Creek
STATION Sc-8
DATE 9-2-64

NUMBER OF ORGANISMS 107
TAXA 8
DIVERSITY 2.19

PLATYHELMINTHES

ANNELIDA

Oligochaeta	2	[illegible]

MOLLUSCA

Gastropoda

Physa sp.	1	[illegible]

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA
PLECOPTERA

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	6	[illegible]

TRICOPTERA

Hydropsyche simulans	8	7.[illegible]
Hydropsyche frisoni	12	12.9
Cheumatopsyche	25	34.9

LEPIDOPTERA

COLEOPTERA

Berosus sp.	3	4

DIPTERA

Tendipedidae	50	[illegible]

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Center Creek STATION Sc-8 DATE 12-1-64

NUMBER OF ORGANISMS 413 1080 - TAXA 12 DIVERSITY 2.01

PLATYHELMINTHES

ANNELIDA

Oligochaeta	3	1.4
Hirudinea	7	5.9

MOLLUSCA

Gastropoda

Physa sp.	2	.6

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA
PLECOPTERA

EPHEMEROPTERA

ODONATA

Argia sp	1	

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	14	.6

TRICOPTERA

Hydropsyche cuanis	30	49.[illegible]
Cheumatopsyche sp.	17	20.9

LEPIDOPTERA

COLEOPTERA

Berosus sp. (L)	2	.6
Optioservus sp. (A)	1	0

DIPTERA

Tendipedidae	205	67[illegible]
Sepedon sp.	5	2.5
Simulium sp.	125	262.1
Eriocera sp.	1	0

MISCELLANEOUS

REMARKS:

51.2

BENTHOS ANALYSIS

STREAM Center Cr. STATION Sc-8 DATE 2-16-65

NUMBER OF ORGANISMS 70 129.[illegible] TAXA 9 1,88 DIVERSITY 2.25

PLATYHELMINTHES

ANNELIDA

Oligochaeta	4	2.[illegible]

MOLLUSCA

Gastropoda

Physa sp.	5	3.[illegible]

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus

TRICOPTERA

Hydropsyche cuanis	2	[illegible]
Cheumatopsyche sp.	3	[illegible]

LEPIDOPTERA

COLEOPTERA

Berosus sp. (L)	5	3.5

DIPTERA

Simulium sp.	30	44.3
Eriocera sp.	1	[illegible]
Tendipedidae	20	26

MISCELLANEOUS

REMARKS:

42.5

1,78

BENTHOS ANALYSIS

STREAM Center Cr. STATION Sc-8 DATE 5-12-65

NUMBER OF ORGANISMS 331 834.1 TAXA 8 1.2 DIVERSITY .66

PLATYHELMINTHES

ANNELIDA

Oligochaeta 7 5.9

MOLLUSCA

Gastropoda

Physa sp. 2 .6

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

EPHEMEROPTERA

Heptagenia sp. 1

ODONATA

Tauriphila sp. 1

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus 12 12.9

TRICOPTERA

Hydropsyche cuanis 1 0

LEPIDOPTERA

COLEOPTERA

Berosus sp. (L) 7 5.9

DIPTERA

Tendipedidae 300 243.1

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Shoal Creek STATION Ss-3 DATE 8-31-64

NUMBER OF ORGANISMS 164 TAXA 27 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	5

MOLLUSCA

Gastropoda

Goniobasis sp.	20

Pelecypoda

Sphaerium sp.	4

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes sp.	1

INSECTA

PLECOPTERA

Acroneuria arida	1

EPHEMEROPTERA

Ephemera sp.	1
Isonychia sp.	6
Baetis sp.	40
Caenis sp.	9
Tricorythodes sp.	1
Choroterpes sp.	1
Potomanthus sp.	5
Stenonema ares	9
S. nepotellum	5
S. pulchellum	11
S. tripunctatum	6
S. interpunctatum	2
Heptagenia sp.	4

ODONATA

Gomphidae (im)	2

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	10

TRICOPTERA

Cheumatopsyche	1
Heliocopsyche sp.	2
Neophylax autumnus	1

LEPIDOPTERA

COLEOPTERA

Stenelmis sp. (L)	4
S. sp. (A)	7
Optioservus sp. (A)	1
O. sp. (L)	1
Psephenus sp. (L)	2

DIPTERA

Eriocera sp.	2

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Shoal Creek STATION Ss-3 DATE 12-16-64

NUMBER OF ORGANISMS 1,276 TAXA 42 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	5

MOLLUSCA

Gastropoda

Amnicola sp.	1
Ferrissia sp.	5
Goniobasis sp.	150

Pelecypoda

Sphaerium sp.	6
Psidium sp.	15

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Orconectes neglectus	1

INSECTA

PLECOPTERA

Hydroperla nalata	19
Isoperla richardsoni	6
Neoperla clymene	2
Allocapnia sp.	16

EPHEMEROPTERA

Potomanthus sp.	2
Caenis sp.	2
Baetis sp.	2
Isonychia sp.	200
Ephemera guttulata	1
Stenonema ares	35
S. pulchellum	23
S. nepotellum	90
S. bipunctatum	17
S. interpunctatum	40

ODONATA

Gomphidae (im.)	2

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	183
Sialis sp.	1

TRICOPTERA

Helicopsyche sp.	4
Chimarra obscura	5
Hydropsyche betteni	1
H. bifida	2
Psychomyia sp.	1
Neophylax sp.	2
Cheumatopsyche sp.	75
Empty cases	2

LEPIDOPTERA

Cataclysta sp.	1

COLEOPTERA

Psephenus sp. (L)	3
Optioservus sp. (L)	100
O. sp. (A)	2
Heterlimnius sp. (L)	7
Stenelmis sp. (L)	9
S. sp. (A)	5

DIPTERA

Tipula sp.	4
Tendipedidae	200
Atherix sp.	3
Tabanus sp.	1
Eriocera sp.	1
Simulidae	24

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Shoal Cr. STATION Ss-3 DATE 2-16-65

NUMBER OF ORGANISMS 885 TAXA 36 DIVERSITY

PLATYHELMINTHES

Planaria	4

ANNELIDA

Oligochaeta	25
Hirudinea	1

MOLLUSCA

Gastropoda

Goniobasis sp.	100
Ferrissia sp.	21
Helisoma sp.	2

Pelecypoda

Sphaerium sp.	5
Psidium sp.	9

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

Hydroperla nalata	7
Isoperla richardsoni	12
Acroneuria sp.	1
Neoperla clymene	1
Allocapnia sp.	1

EPHEMEROPTERA

Isonychia sp.	90
Potomanthus sp	12
Ephemera guttulata	11
Stenonema interpunctatum	23
S. pulchellum	80
S. ares	12
Ephemerella bicolor	1

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	14

TRICOPTERA

Chimarra obscura	8
Cheumatopsyche sp.	110
Neophylax sp.	5
Helicopsyche sp.	21
Glossosoma intermedia	6
Polycentropus flavus	1

LEPIDOPTERA

Cataclysta sp.	2

COLEOPTERA

Psephenus sp. (L)	13
Stenelmis sp. (L)	8
Stenelmis sp. (A)	1
Optioservus sp. (L)	65

DIPTERA

Tabanus sp.	2
Hexatoma sp.	3
Tipula sp.	1
Simulidae	7
Tendipedidae	200

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Shoal Creek STATION Ss-4 DATE 8-31-64

NUMBER OF ORGANISMS 186 TAXA 22 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	1

MOLLUSCA

Gastropoda

Goniobasis sp.	20

Pelecypoda

Sphaerium sp.	5

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Immature	2

INSECTA

PLECOPTERA

EPHEMEROPTERA

Ephemera sp.	14
Caenis sp.	15
Tricorythodes sp.	60
Isonychia sp.	1
Choroterpes sp.	9
Baetis sp.	15
Stenonema sp.	4
S. tripunctatum	4
S. bipunctatum	3
S. interpunctatum	2
Heptagenia lucidipennis	2

ODONATA

Argia sp.	5
Gomphidae (im.)	3

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	7

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	4
Stenelmis sp. (A)	3
S. sp. (L)	2
Optioservus sp. (L)	1

DIPTERA

Chrysops sp.	2
Tendipedidae	2

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Shoal Cr. STATION Ss-3 DATE 5-11-65

NUMBER OF ORGANISMS 1340 TAXA 40 DIVERSITY

PLATYHELMINTHES

Planaria	3

ANNELIDA

Oligochaeta	4

MOLLUSCA

Gastropoda

Goniobasis sp.	75
Ferrissia sp.	3
Amnicola	1

Pelecypoda

Psidium sp.	9

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Asellus sp.	1

Decapoda

Orconectes neglectis	7
Immature	43

INSECTA

PLECOPTERA

Perlesta placida	1
Neophasganophora	1
Acroneuria arida	1
Neoperla clymene	3

EPHEMEROPTERA

Ephemera simulans	11
Caenis sp.	4
Baetis sp.	70
Potomanthus sp.	6
Heptagenia sp.	17
Isonychia sp.	122
Stenonema ares	70
S. nepotellum	80
S. tripunctatum	200
S. bipunctatum	90
S. interpunctatum	300
S. pulchellum	35

ODONATA

Ophiogomphus sp.	5
Argia sp.	2
Gomphidae	2

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	23

TRICOPTERA

Helicopsyche sp.	10
Cheumatopsyche sp.	7
Chimarra obscura	2
Hesperophylax sp.	1
Agapetus sp.	2

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	20
Optioscrvus sp. (L)	13
Stenelmis sp. (A)	5

DIPTERA

Tendipedidae	60
Atherix variegata	1
Tipula sp.	1

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Shoal Creek STATION Ss-4 DATE 12-16-64

NUMBER OF ORGANISMS 735 TAXA 34 DIVERSITY

PLATYHELMINTHES	
ANNELIDA	
Oligochaeta	40
Hirudinea	2
MOLLUSCA	
Gastropoda	
Goniobasis sp.	75
Ferrissia sp.	7
Amnicola sp.	2
Pelecypoda	
Sphaerium sp.	30
Psidium sp.	10
CRUSTACEA	
Phyllopoda	
Amphipoda	
Isopoda	
Decapoda	
Orconectes punctimanus	1
INSECTA	
PLECOPTERA	
Neoperla clymene	2
Hydroperla nalata	21
Allocapnia sp.	8
Perlesta sp.	3

EPHEMEROPTERA	
Potomanthus sp.	5
Ephemera simulans	50
Ephemera sp.	10
Caenis sp.	8
Isonychia sp.	47
Baetis sp.	1
Tricorythodes sp.	1
Stenonema ares	40
Stenonema interpunctatum	12
Stenonema pulchellum	25
Stenonema nepotellum	16
ODONATA	
Argia sp.	2
Gomphidae (im.)	5
HEMIPTERA	
NEUROPTERA	
MEGALOPTERA	
Corydalus cornutus	9

TRICOPTERA	
Cheumatopsyche sp.	8
LEPIDOPTERA	
COLEOPTERA	
Psephenus sp. (L)	7
Optioservus sp. (L)	50
Heterlimnius sp. (L)	3
Stenelmis sp. (L)	12
S. sp. (A)	1
Optioservus sp. (A)	5
DIPTERA	
Tendipedidae	200
Simulidae	17
MISCELLANEOUS	

REMARKS:

BENTHOS ANALYSIS

STREAM Shoal Creek STATION Ss-4 DATE 2-16-65

NUMBER OF ORGANISMS 561 TAXA 35 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	60

MOLLUSCA

Gastropoda

Somatogyrus sp.	3
Goniobasis sp.	45
Ferrissia sp.	4

Pelecypoda

Sphaerium sp.	7

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

Hydroperla nalata	2
Isoperla richardsoni	3
Neoperla clymene	1

EPHEMEROPTERA

Caenis sp.	9
Isonychia sp.	50
Potomanthus sp.	3
Leptophlebia sp.	2
Ephemera simulans	60
Pseudocloeon sp.	1
Stenonema ares	25
S. pulchellum	12
S. bipunctatum	30
S. interpunctatum	35

ODONATA

Ophiogomphus sp.	1
Argia sp.	7
Gomphidae	2

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	3

TRICOPTERA

Helicopsyche sp.	2
Cheumatopsyche sp.	2
Hydroptilidae	2
Polycentropus sp.	1
Neophylax sp.	4

LEPIDOPTERA

COLEOPTERA

Stenelmis sp. (L)	6
Stenelmis sp. (A)	2
Optioservus sp. (L)	12
Psephenus sp. (L)	1
Gonielmis sp. (L)	2

DIPTERA

Simulium	7
Tendipedidae	150
Tabanus sp.	4
Eriocera sp.	1

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Shoal Cr. STATION Ss-4 DATE 5-11-65

NUMBER OF ORGANISMS 359 TAXA 31 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	25
Hirudinea	1

MOLLUSCA

Gastropoda

Goniobasis sp.	31

Pelecypoda

Sphaerium sp.	3

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Lirceus sp.	1

Decapoda

Orconectes sp.	14

INSECTA

PLECOPTERA

Neoperla clymene	1
Acroneuria arida	1

EPHEMEROPTERA

Baetis sp.	20
Ephemerella bicolor	1
Tricorythodes sp.	4
Caenis sp.	6
Isonychia sp.	3
Potomanthus sp.	9
Ephemera varia	6
E. guttulata	8
Stenonema ares	21
S. nepotellum	30
S. interpunctatum	63
S. femoratum	46

ODONATA

Argia sp.	3
Gomphidae	5

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	1

TRICOPTERA

Cheumatopsyche sp.	1

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	5
Stenelmis sp. (L)	10
Stenelmis sp. (A)	4
Optioservus sp. (L)	15
Optioservus sp. (A)	1

DIPTERA

Tendipedidae	22
Syrphidae	1

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Shoal Creek STATION Ss-10 DATE 9-3-64

NUMBER OF ORGANISMS 223 TAXA 28 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	2
Hirudinea	2

MOLLUSCA

Gastropoda

Goniobasis sp.	48
Physa sp.	2

Pelecypoda

Sphaerium sp.	18

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

Immature	1

INSECTA

PLECOPTERA

Neophasgorophora capitata	4

EPHEMEROPTERA

Isonychia sp.	1
Tricorythodes sp.	11
Baetis sp.	15
Choroterpes sp.	5
Heptagenia sp.	3
Stenonema sp.	12
S. bipunctatum	7
S. pulchellum	3

ODONATA

Gomphidae (im.)	4
Argia sp.	2

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	6

TRICOPTERA

Helicopsyche sp.	3
Cheumatopsyche sp.	20
Chimarra obscura	5
Neophylax sp.	3

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	7
Stenelmis sp. (A)	18
S. sp. (L)	9
Optioservus sp. (L)	3

DIPTERA

Tendipedidae	7
Hemerodromia sp.	1
Simulium sp.	1

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Shoal Creek STATION Ss-10 DATE 12-2-64

NUMBER OF ORGANISMS 1,778 TAXA 39 DIVERSITY

PLATYHELMINTHES	
Planaria	31
ANNELIDA	
Oligochaeta	23
Hirudinea	5
MOLLUSCA	
Gastropoda	
Goniobasis sp.	105
Physa sp.	22
Ferrissia sp.	29
Pelecypoda	
Sphaerium sp.	64
CRUSTACEA	
Phyllopoda	
Amphipoda	
Isopoda	
Lirceus sp.	50
Asellus stygius	8
Decapoda	
INSECTA	
PLECOPTERA	
Neoperla clymene	42
Taeniopteryx maura	1
Allocapnia sp.	4
Neoph asgonophora capitata	80

EPHEMEROPTERA	
Isonychia sp.	80
Pseudocloeon sp.	1
Tricorythodes sp.	30
Ephemera varia	1
Stenonema ares	60
S. interpunctatum	35
S. tripunctatum	17
S. pulchellum	25
S. nepotellum	100
ODONATA	
Gomphidae (im.)	2
Argia sp.	35
Hetaerina sp.	1
HEMIPTERA	
NEUROPTERA	
MEGALOPTERA	
Corydalus cornutus	8

TRICOPTERA	
Helicopsyche sp.	7
Cheumatopsyche sp.	125
Hydropsyche aerata	2
H. betteni	4
Chimarra obscura	400
LEPIDOPTERA	
COLEOPTERA	
Psephenus sp. (L)	135
Stenelmis sp.	60
Optioservus sp.	17
Cylloepus sp.	6
Helichus sp.	1
DIPTERA	
Tendipedidae	150
Simulidae	11
Tipula sp.	1
MISCELLANEOUS	

REMARKS:

BENTHOS ANALYSIS

STREAM Shoal Cr. STATION Ss-10 DATE 2-16-65

NUMBER OF ORGANISMS 1363 TAXA 34 DIVERSITY

PLATYHELMINTHES

Planaria	10

ANNELIDA

Oligochaeta	10
Hirudinea	4

MOLLUSCA

Gastropoda

Gyraulus sp.	3
Physa sp.	5
Goniobasis sp.	27
Ferrissia sp.	8

Pelecypoda

Sphaerium sp.	35

CRUSTACEA

Phyllopoda

Amphipoda

Synurella sp.	1

Isopoda

Lirceus sp.	28
Asellus tridentatus	1

Decapoda

Palaemonetes kadiakensis	1

INSECTA

PLECOPTERA

Hydroperla nalata	1
Neoperla clymene	21
Neophasgonophora capitata	24
Allocapnia sp.	1
Branchyptera fasciata	1

EPHEMEROPTERA

Isonychia sp.	60
Caenis sp.	2
Tricorythodes sp.	6
Stenonema interpunctatum	24
S. tripunctatum	90
S. nepotellum	125
S. bipunctatum	13

ODONATA

Argia sp.	9
Gomphidae	3

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	2

TRICOPTERA

Chimarra obscura	19
Cheumatopsyche sp.	60

LEPIDOPTERA

COLEOPTERA

Psephenus sp. (L)	10
Stenelmis sp. (L)	200
Stenelmis sp. (A)	2
Optioservus sp. (L)	12

DIPTERA

Simulium sp.	45
Tendipedidae	500

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Shoal Cr. STATION Ss-10 DATE 5-11-65

NUMBER OF ORGANISMS 270 TAXA 28 DIVERSITY

PLATYHELMINTHES

Planaria sp.	1

ANNELIDA

Hirudinea	1

MOLLUSCA

Gastropoda

Gyraulus sp.	1
Goniobasis sp.	7

Pelecypoda

Sphaerium sp.	2

CRUSTACEA

Phyllopoda

Amphipoda

Crangonyx sp.	1

Isopoda

Lirceus sp.	8

Decapoda

Orconectes eupunctus	1

INSECTA

PLECOPTERA

Perlesta placida	1
Neoperla clymene	5

EPHEMEROPTERA

Isonychia sp.	40
Tricorythodes sp.	2
Heptagenia sp.	6
Stenonema ares	7
S. interpunctatum	2
S. nepotellum	17
S. bipunctatum	21
Baetis sp.	90

ODONATA

Tauriphila sp.	1

HEMIPTERA

NEUROPTERA

MEGALOPTERA

Corydalus cornutus	1

TRICOPTERA

Cheumatopsyche sp.	3
Leptocerus sp.	1

LEPIDOPTERA

COLEOPTERA

Stenelmis sp. (L)	5
Stenelmis sp. (A)	8
Optioservus sp. (L)	9
Psephenus sp. (L)	1

DIPTERA

Tendipedidae	25
Simulium sp.	3

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Turkey Creek STATION St-9 DATE 9-2-64

NUMBER OF ORGANISMS 93 TAXA 5 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	50

MOLLUSCA

Gastropoda

Physa sp.	7
Planorbidae	2

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

Cheumatopsyche sp.	4

LEPIDOPTERA

COLEOPTERA

DIPTERA

Tendipedidae	30

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Turkey Cr. STATION St-9 DATE 2-17-65

NUMBER OF ORGANISMS 150 TAXA 2 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	100

MOLLUSCA

Gastropoda

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

DIPTERA

Tendipedidae	50

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Turkey Creek STATION St-9 DATE 12-1-64

NUMBER OF ORGANISMS 1,132 TAXA 5 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	1000

MOLLUSCA

Gastropoda

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA

PLECOPTERA

EPHEMEROPTERA

Isonychia sp.	1

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

Chimarra aterrima	5

LEPIDOPTERA

COLEOPTERA

Optioservus sp. (L)	1

DIPTERA

Tendipedidae	125

MISCELLANEOUS

REMARKS:

BENTHOS ANALYSIS

STREAM Turkey Cr. STATION St-9 DATE 5-11-65

NUMBER OF ORGANISMS 804 TAXA 4 DIVERSITY

PLATYHELMINTHES

ANNELIDA

Oligochaeta	500

MOLLUSCA

Gastropoda

Physa sp.	3

Pelecypoda

CRUSTACEA

Phyllopoda

Amphipoda

Isopoda

Decapoda

INSECTA
PLECOPTERA

EPHEMEROPTERA

ODONATA

HEMIPTERA

NEUROPTERA

MEGALOPTERA

TRICOPTERA

LEPIDOPTERA

COLEOPTERA

Stenelmis sp. (A)	1

DIPTERA

Tendipedidae	300

MISCELLANEOUS

REMARKS:

WATER QUALITY
of
JAMES, SPRING AND ELK
RIVER BASINS

1965

APPENDIX D

WATER QUALITY DATA

Missouri Geological Survey and Water Resources
Missouri Department of Conservation
Missouri Water Pollution Board

Published by

The Department of Public Health and Welfare

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Jefferson City, Missouri 65101

APPENDIX D

WATER QUALITY DATA

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SYMBOLS AND ABBREVIATIONS

The following symbols and abbreviations are employed throughout the appendixes of this report:

L.A.	- Laboratory accident
	- No data
M.G.D.	- Million gallons per day
cfs	- Cubic feet per second
ppm	- Parts per million by weight
>	- Greater than
<	- Less than
cm	- Centimeter
ml	- Milliliter
^{o}C	- Degrees centigrade
phth	- Phenolphthalein
Hwy.	- Highway
L.W.	- Low water
Sec.	- Section
Sur.	- Survey
T	- Township
R	- Range
d	- Dead
a	- Alive
p	- Present
M	- Municipal
P	- Private
P.E.	- Population Equivalent
H	- Softening
F	- Filtration
C	- Chemical
I	- Iron or manganese removal
D	- Disinfection
Befr. Trt.	- Before Treatment
*	- Estimated
+	- Field data where mixed with laboratory data

APPENDIX D

WATER QUALITY DATA

Method of Analysis

The methods of analysis employed are basically those recommended in STANDARD METHODS FOR THE EXAMINATION OF WATER AND WASTE WATER INCLUDING BOTTOM SEDIMENTS AND SLUDGE, Eleventh Edition, 1960, prepared and published jointly by the American Public Health Association, American Water Works Association and Water Pollution Control Federation. The methods were modified where it was necessary to take care of interfering substances. In all cases approved methods were used. Listed is a tabulation of the observations made at all stations in the James, Spring, and Elk River Basins.

The data is tabulated by basin areas as follows:

Table I - James River Basin of the White River Basin
Table II - Spring River Basin
Table III - Elk River Basin

TABLE I

JAMES RIVER BASIN WATER QUALITY DATA

Station	Air Temp. °C				Flow in cfs				Water Temp. °C				Dissolved Oxygen ppm				Dissolved Oxygen % Saturation			
	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.
J-1	37	14	3	19	1.0	0.6	34.5	103	30	16	4	14	6.7	8.2	12.7	12.0	88	82	97	115
J-2	37	12	6	19	1.8	0.3	40.9	126	30	12	3	11	5.5	6.6	13.6	13.0	72	62	101	117
Jp-1	26	15	4	17	3.5	1.7	8.8	28.1	21	9	9	12	8.4	10.2	13.5	14.3	93	88	116	132
Js-1	35	12	11	17	0.5	0.6	2.7	7.3	30	14	9	18	10.1	16.4	12.7	11.8	132	158	109	124
J-3	25	16	11	11	8.5	10.2	58.5	224	26	12	6	17	6.3	8.6	11.9	12.0	77	80	95	111
J-4	32	20	12	11	12.2	8.5	65.9	258	28	12	5	15	8.8	9.8	11.9	11.8	111	91	93	116
Jwsp-1	35	16	6	10	16.3	15.3	13.4	36.3	23	17	12	14	1.3	0.8	4.5	7.4	15	7	42	71
Jw-1	35	16	6	10	1.5	12.0	10.0	22.7	27	19	8	14	6.7	3.3	6.6	10.9	83	35	55	105
Jw-2	35	19	5	14	10.5	16.3	27.8	96.0	27	12	7	13	7.6	1.2	7.8	11.1	93	11	64	104
J-5	33	24	6	11	42.6	36.5	120	378	29	12	5	16	8.8	4.9	9.0	13.2	113	45	70	132
Jf-1	28	24	-8	22	9.9	8.8	27.2	85.1	23	16	2	18	7.0	7.6	12.7	12.4	80	76	99	131
Jf-2	32	18	8	21	9.9	11.6	35.6	102	26	16	3	18	9.0	9.2	13.9	11.6	110	92	103	122
Jf-3	25	25	-5	21	19.3	16.0*	49.0	122	23	16	3*	21	4.5	6.8	14.4	12.0	52	68	107	130
Jf-4	33	20	-5	24	28.6	20.0	63.0	169	25	16	4	18	9.0	9.2	13.9	14.1	107	92	106	148
J-6	32	20	8	14	64.8	53.2	188*	600	29	12	4	17	9.7	6.6	12.7	11.3	124	61	97	116
Jc-1	35	24	6	17	26.3	21.5	56.2	204	28	14	6	14	9.7	11.5	13.1	13.0	123	111	105	125
J-7	34	24	3	20	99.5	67.1	242	977	29	14	4	17	11.8	11.9	12.3	14.7	151	114	94	152
J-8	32	9	2	20	87.3	78.7	256	1,010	27	11	3	17	10.9	10.3	12.3	14.5	135	93	91	148
Jfl-1	30	18	-10	23	5.9	3.8	6.8	32.8	24	18	1	17	9.4	12.4	11.9	12.4	111	131	84	128
Jfl-2	28	12	-7	24	27.9	35.2	64.2	179	25	14	4	20	6.6	8.8	15.6	12.2	78	85	116	117

*Estimated

DATES STREAMS WERE SAMPLED

STREAM	STATION	SUMMER	FALL	WINTER	SPRING
James River	J-1 through 8	8-(3-6-5)-64	10-(19-20-21)-64	1-(18-19-20)-65	4-(27-28-29)-65
Pearson Creek	Jp-1	8-5-64	10-20-64	1-18-65	4-27-65
Sequiota	Js-1	8-4-64	10-19-64	1-19-65	4-27-65
Rader Spring	Jwsp-1	8-4-64	10-20-64	1-19-65	4-28-65
Wilson Creek	Jw-1,2	8-4-64	10-(20-21)-64	1-19-65	4-28-65
Finley Creek	Jf-1 through 4	8-20-64	10-11-(19-5)-64	2-1-65	5-3-65
Crane Creek	Jc-1	8-6-64	10-21-64	1-20-65	4-29-65
Flat Creek	Jfl-1,2	8-(6-19)-64	11-(4-5)-64	2-(1-2)-65	5-(3-4)-65

TABLE I

JAMES RIVER BASIN WATER QUALITY DATA

	p^H				Phth. Alk. as CaCO3 ppm				Total Alkalinity as $CaCO_3$ ppm				Mg. Hardness as $CaCO_3$ ppm				Calcium Hardness as $CaCO_3$ ppm				Specific Cond. micromhos/cm			
Station	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.
J-1	7.1	7.8	7.9	8.5	0	0	0	7	117	168	135	110	40	43	55	30	100	115	98	84	290	300	270	200
J-2	7.7	7.6	7.8	8.2	0	0	0	0	148	159	140	112	44	45	47	20	104	115	108	96	290	280	280	200
Jp-1	8.1	8.0	8.1	7.6	0	0	0	0	155	184	174	135	12	17	2	8	178	195	182	150	300	400	370	300
Js-1	8.3	8.5	8.4	8.5	2	9	7	4	135	166	184	131	18	20	18	18	130	148	182	128	300	350	380	275
J-3	8.1	8.0	8.1	8.4	0	0	0	5	153	157	150	133	18	10	25	22	152	155	139	114	300	310	320	250
J-4	8.1	7.8	8.1	8.1	0	0	0	0	162	176	159	144	10	13	15	32	166	177	147	126	320	350	320	250
Jwsp-1	7.5	7.5	7.3	7.2	0	0	0	0	221	292	213	130	14	6	13	3	166	172	200	195	650	770	520	450
Jw-1	7.9	7.9	7.7	7.5	0	0	0	0	248	326	300	140	12	8	10	10	164	155	204	207	800	900	800	700
Jw-2	7.9	7.6	7.7	7.3	0	0	0	0	203	279	247	158	10	18	4	20	180	165	204	185	560	800	700	475
J-5	8.3	7.7	7.8	8.5	4	0	0	5	173	211	185	153	14	6	26	32	170	187	166	136	460	550	430	300
Jf-1	8.0	7.7	7.9	8.2	0	0	0	0	140	160	149	122	42	33	49	28	110	120	108	91	270	280	270	225
Jf-2	8.4	8.1	8.0	8.1	4	0	0	0	137	171	144	121	38	51	53	8	108	112	104	101	260	280	270	225
Jf-3	7.8	7.7	8.1	LA	0	0	0	LA	146	175	153	LA	26	35	18	20	134	135	137	104	300	300	300	250
Jf-4	8.3	8.1	8.1	8.2	2	0	0	0	153	184	151	133	22	25	22	20	140	157	149	121	300	320	300	250
J-6	8.6	7.8	7.8	LA	11	0	0	LA	167	189	170	LA	10	8	19	15	160	175	159	133	380	450	350	300
Jc-1	8.5	8.2	8.1	8.2	4	0	0	0	135	162	151	121	10	5	11	22	134	153	145	121	255	290	290	250
J-7	8.5	8.5	7.9	8.5	5	9	0	5	158	180	164	135	16	15	19	25	152	165	153	128	325	380	340	250
J-8	LA	8.2	7.9	8.6	LA	0	0	9	LA	189	164	139	18	7	21	35	152	173	153	126	320	380	340	250
Jfl-1	8.3	8.3	7.6	7.9	2	2	0	0	128	150	140	112	8	10	10	5	134	139	137	114	260	260	250	225
Jfl-2	8.0	7.9	8.0	8.5	0	0	0	4	139	157	140	117	26	22	27	18	124	133	122	101	270	270	250	210

DATES STREAMS WERE SAMPLED

STREAM	STATION	SUMMER	FALL	WINTER	SPRING
James River	J-1 through 8	8-(3-5-6)-64	10-(19-20-21)-64	1-(18-19-20)-65	4-(27-28-29)-65
Pearson Creek	Jp-1	8-5-64	10-20-64	1-18-65	4-27-65
Sequiota	Js-1	8-4-64	10-19-64	1-19-65	4-27-65
Rader Spring	Jwsp-1	8-4-64	10-20-64	1-19-65	4-28-65
Wilson Creek	Jw-1,2	8-4-64	10-(20-21)-64	1-19-65	4-28-65
Finley Creek	Jf-1 through 4	8-20-64	10-11-(19-5)-64	1-19-65	5-3-65
Crane Creek	Jc-1	8-6-64	10-21-64	1-20-65	4-29-65
Flat Creek	Jfl-1,2	8-(6-19)-64	11-(4-5)-64	2-(1-2)-65	5-(3-4)-65

TABLE I

JAMES RIVER BASIN WATER QUALITY DATA

Station	Nitrite as N ppm				Nitrate as N ppm				Ammonia as N ppm				Orthophosphate as PO_4 ppm			
	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.
J-1	0.000	0.000	0.007	0.030	.2	0.1	.5	1.1	0.9	0.55	0.30	5.5	0.08	0.08	0.10	0.06
J-2	0.000	0.000	0.000	0.005	0.1	<0.1		0.8	0.45	0.70	0.20	0.35	<0.2+	<0.2+		<0.2+
Jp-1	0.015	0.005	0.005	0.005	4.3	3.6	3.2	4.1	0.35	0.90	0.35	0.45	0.09	0.13	0.10	0.06
Js-1	0.015	0.010	0.015	0.015	1.7	0.9	1.6	3.8	0.35	0.60	0.60	0.35	0.08	0.14	0.07	0.00
J-3	0.005	<0.005	0.007	0.010	0.7	0.2	0.7	1.9	0.45	0.70	0.35	0.35	0.10	0.09	0.04	0.10
J-4	0.005	0.005	0.005	0.015	1.3	0.9	0.9	2.1	0.70	0.60	0.35	0.35	0.07	0.09	0.07	0.09
Jwsp-1	0.500	0.200	0.070	0.150	0.7	0.3	1.2	4.1	11	18	16	2.0	17	11	0.64	21
Jw-1	1.10	1.000	0.150	0.200	0.1	0.2	0.2	1.7	28	26	40	14	27	29	16	9.1
Jw-2	0.600	0.600	1.10	0.150	1.9	0.8	0.5	5.4	10	22	32	10	16	22	8.3	3.1
J-5	0.080	0.125	0.080	0.085	0.1	2.5	2.3	2.7	0.30	3.5	3.2	0.90	0.16	11	1.9	0.21
Jf-1	<0.005	<0.005	0.005	0.005	0.3	0.1	0.4	1.0	0.35	0.55	0.45	0.70	0.05	0.00	0.08	<0.2+
Jf-2	<0.005	<0.005	0.005	0.005	0.3	<0.1		0.8	0.55	0.60	0.45	0.55		<0.2+		0.3+
Jf-3	0.015	<0.005	0.005	0.008	<0.1	0.0	<0.1	1.4	0.25	0.60	0.30	0.45	0.22	0.16	0.06	0.11
Jf-4	0.005	0.005	0.005	0.005	0.9	0.4	1.0	2.1	0.35	0.55	0.70	0.70	0.13	0.00	0.14	0.00
J-6	0.010	0.110	0.025	0.060	<0.1	2.0		0.6	0.45	0.90	0.90	0.50	3.0+	6.0+		0.4+
Jc-1	0.015	0.005	0.005	0.050	1.7	1.6	1.8	2.7	0.35	0.35	0.25	0.25	0.06	0.12	0.12	0.09
J-7	0.007	0.008	0.015	0.015	1.0	2.1	2.2	2.3	0.55	0.20	0.55	0.45	1.5	1.9	0.37	0.12
J-8	0.005	0.005	0.015	0.015	0.3	1.3	2.0	2.3	0.10	0.30	0.35	0.45	1.2	2.6	0.86	0.02
Jfl-1	0.008	0.010	<0.005	0.008	1.4	0.8	0.4	2.2	0.20	0.55	0.35	0.35	0.05	0.14	0.13	0.00
Jfl-2	<0.005	0.005	0.005	0.005		0.3	1.2	1.2	0.25	0.70	1.1	0.50		0.00	0.16	0.00

+ Field Data

DATES STREAMS WERE SAMPLED

STREAM	STATION	SUMMER	FALL	WINTER	SPRING
James River	J-1 through 8	8-(3-5-6)-64	10-(19-20-21)-64	1-(18-19-20)-65	4-(27-28-29)-65
Pearson Creek	Jp-1	8-5-64	10-20-64	1-18-65	4-27-65
Sequiota	Js-1	8-4-64	10-19-64	1-19-65	4-27-65
Rader Spring	Jwsp-1	8-4-64	10-20-64	1-19-65	4-28-65
Wilson Creek	Jw-1,2	8-4-64	10-(20-21)-64	1-19-65	4-28-65
Finley Creek	Jf-1 through 4	8-20-64	10-11-(19-5)-64	2-1-65	5-3-65
Crane Creek	Jc-1	8-6-64	10-21-64	1-20-65	4-29-65
Flat Creek	Jfl-1,2	8-(6-19)-64	11-(4-5)-64	2-(1-2)-65	5-(3-4)-65

TABLE I

JAMES RIVER BASIN WATER QUALITY DATA

Station	Detergents as ABS ppm				Coliform Bacteria per 100 ml.				Fecal Streptococcus per 100 ml.				Turbidity Units			
	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.
J-1	0.0	0.0	0.0	0.0	200	22	24	62	—	120	2	8	<5	5	<5	15
J-2					100	110	6	54		370	4	10	<5	6	<5	10
Jp-1	0.1	0.1	0.0	0.0	5,200	210	12	290		410	2	10	<5	<5	<5	10
Js-1	0.1	0.1	0.0	0.1	1,400	770	10	4,300	540	680	26	170	10	9	<5	9
J-3	0.0	0.0	0.0	0.0	360	80	6	230		90	22	10	15	6	<5	12
J-4	0.0	0.0	0.0	0.0	400	70	<2	180	27	38	2	38	15	6	<5	6
Jwsp-1	1.6	2.3	0.5	0.2	40,000	10,000	10,000	9,000	2,600	6,800	4,400	1,100	22	17	8	15
Jw-1	1.6	3.9	1.6	0.6	340,000	6,000	76,000	230,000	560	1,200	20,000	3,100	23	24	15	13
Jw-2	1.6	2.4	0.8	0.3	8,800	2,600	110	80,000		1,300	170	700	13	15	8	15
J-5	0.3	0.8	0.2	0.1	1,000	460	5,200	2,300	100	58	10	40	14	9	5	11
Jf-1	0.1	0.0	0.0	0.1	280	4	<2	34	85	4	<2	18	5	<5	<5	<5
Jf-2					30	4	<2	40	33	<2	<2	12	7	<5	<5	<5
Jf-3	0.0	0.1	0.0	0.1	10,000	1,300	170	5,200	5,000	300	140	50	5	<5	<5	<5
Jf-4	0.0	0.0	0.0	0.0	280	6	4	140	120	8	6	12	17	8	<5	<5
J-6					LA	20	92	580	14	10	<2	16	14	5	<5	9
Jc-1	0.0	0.0	0.1	0.0	50	70	28	280	48	130	4	12	6	<5	<5	6
J-7	0.1	0.2	0.1	0.1	LA	24	24	26		4	2	10	8	9		9
J-8	0.1	0.2	0.1	0.1	LA	140	30	28	8	8	2	<2	13	10	<5	10
Jf1-1	0.0	0.2	0.2	0.0	270	18	1,500	1,900	4	290	92	170	6	<5	<5	5
Jf1-2		0.0	0.0	0.0	<2	22	2	160		74	<2	62	<5	<5	<5	<5

DATES STREAMS WERE SAMPLED

STREAM	STATION	SUMMER	FALL	WINTER	SPRING
James River	J-1 through 8	8-(3-5-6)-64	10-(19-20-21)-64	1-(18-19-20)-65	4-(27-28-29)-65
Pearson Creek	Jp-1	8-5-64	10-20-64	1-18-65	4-27-65
Sequiota	Js-1	8-4-64	10-19-64	1-19-65	4-27-65
Rader Spring	Jwsp-1	8-4-64	10-20-64	1-19-65	4-28-65
Wilson Creek	Jw-1,2	8-4-64	10-(20-21)-64	1-19-65	4-28-65
Finley Creek	Jf-1 through 4	8-20-64	10-11-(19-5)-64	2-1-65	5-3-65
Crane Creek	Jc-1	8-6-64	10-21-64	1-20-65	4-29-65
Flat Creek	Jf1-1,2	8-(6-19)-64	11-(4-5)-64	2-(1-2)-65	5-(3-4)-65

JAMES RIVER BASIN WATER QUALITY DATA

	Color				Iron as Fe ppm				Manganese as Mm ppm				Sulfate as SO_4 ppm			
Station	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.
J-1	2	3	5	0	0.00	C.00	0.00	0.00	0.00	0.00	0.01	0.00	9.2	8.6	13	50
J-2																
Jp-1	5	5	5	0	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	20	20	14	2.2
Js-1	5	5	5	0	0.00	C.02	0.00	0.05	0.00	0.00	0.00	0.00	12	13	15	14
J-3	3	5	5	1	0.00	0.02	0.00	0.02	0.00	0.00	0.01	0.00	21	22	16	19
J-4	4	7	5	2	0.00	0.05	0.00	0.00	0.01	0.00	0.01	0.00	21	19	15	11
Jwsp-1	20	10	5	1	0.04	0.25	0.04	0.18	0.00	0.02	0.00	0.00	38	32	22	19
Jw-1	25	30	10	6	0.02	0.30	0.19	0.42	0.00	0.02	0.00	0.00	52	45	50	43
Jw-2	15	20	10	1	0.09	0.20	0.11	0.13	0.00	0.03	0.01	0.00	31	36	38	22
J-5	6	15	5	1	0.01	0.07	0.01	0.01	0.00	0.00	0.00	0.00	20	28	20	13
Jf-1	5	5	5	1	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	7.6	10	10	7.6
Jf-2																
Jf-3	5	5	0	1	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	6.8	10	8.6	8.0
Jf-4	5	5	0	2	0.02	0.02	0.01	0.00	0.00	0.00	0.00	0.00	6.0	7.6	8.0	6.6
J-6																
Jc-1	5	5	5	2	0.00	C.00	0.19	0.01	0.00	0.00	0.00	0.00	4.4	4.4	6.0	6.4
J-7	5	10	5	6	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	10	13	12	11
J-8	10	10	5	1	0.00	C.02	0.00	0.00	0.00	0.01	0.00	0.00	11	13	13	8.8
Jf1-1	5	5	0	0	0.00	0.01	0.03	0.00	0.00	0.00	0.00	0.00	4.8	5.2	4.6	4.4
Jf1-2		5	1	1		0.00	0.03	0.00		0.00	0.00	0.00		6.0	7.4	6.0

DATES STREAMS WERE SAMPLED

STREAM	STATION	SUMMER	FALL	WINTER	SPRING
James River	J-1 through 8	8-(3-5-6)-64	10-(19-20-21)-64	1-(18-19-20)-65	4-(27-28-29)-65
Pearson Creek	Jp-1	8-5-64	10-20-64	1-18-65	4-27-65
Sequiota	Js-1	8-4-64	10-19-64	1-19-65	4-27-65
Rader Spring	Jwsp-1	8-4-64	10-20-64	1-19-65	4-28-65
Wilson Creek	Jw-1,2	8-4-64	10-(20-21)-64	1-19-65	4-28-65
Finley Creek	Jf-1 through 4	8-20-64	10-11-(19-5)-64	2-1-65	5-3-65
Crane Creek	Jc-1	8-6-64	10-21-64	1-20-65	4-29-65
Flat Creek	Jf1-1,2	8-(6-19)-64	11-(4-5)-64	2-(1-2)-65	5-(3-4)-65

TABLE I

JAMES RIVER BASIN WATER QUALITY DATA

	Silica as SiO_2 ppm				Sodium as Na ppm				Potassium as K ppm				Chloride as Cl^- ppm				Flouride as F^- ppm			
Station	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.
J-1 J-2	11	8.5	1.6	5.9	3.1	2.8	3.0	2.4	1.9	1.7	1.5	1.2	7.0	6.0	7.0	4.7	0.1	0.1	0.0	0.0
Jp-1	9.8	9.5	12	8.5	6.2	6.4	5.7	4.5	1.7	2.0	1.3	1.0	13	11	8.3	7.3	1.4	1.4	0.6	0.1
Js-1	7.9	5.3	9.8	12	8.8	12	12	6.2	1.6	2.3	1.5	1.1	13	16	15	9.4	0.2	0.2	0.2	0.1
J-3	9.8	6.2	9.3	6.2	4.7	5.0	4.4	3.1	1.9	2.2	1.4	1.2	8.5	9.0	6.9	5.5	0.1	0.2	0.0	0.0
J-4	11	7.6	9.9	6.6	32	4.4	4.2	3.6	5.2	1.7	1.4	1.2	37	7.0	6.8	5.4	0.4	0.1	0.0	0.0
Jwsp-1	13	16	14	9	58	63	30	2.3	10	9.6	3.8	3.1	60	28	35	33	0.8	0.7	0.3	0.2
Jw-1	15	18	17	10	82	93	70	57	15	14	10	8.1	84	85	67	86	2.2	1.9	0.6	0.6
Jw-2	12	15	16	8.2	56	69	57	27	9.9	5.5	6.7	3.8	63	111	61	37	0.7	0.8	0.5	0.3
J-5	11	11	11	6.9	31	43	17	7.3	5.1	6.7	3.1	1.6	36	48	19	9.8	0.4	0.5	0.1	0.1
Jf-1 Jf-2	8.7	9.1	9.8	5.5	2.6	2.8	2.4	2.4	1.4	1.2	1.0	1.1	4.0	3.7	9.0	4.1	0.0	0.2	0.1	0.0
Jf-3	11	9.1	6.4	5.3	3.4	4.1	2.8	3.1	1.8	1.7	0.8	1.3	4.0	4.1	5.1	4.7	0.0	0.2	0.2	5.0
Jf-4	10	9.3	6.9	5.8	3.4	4.0	2.8	2.7	1.6	1.6	0.8	1.2	4.0	4.1	4.8	4.6	0.0	0.2	0.2	0.0
J-6																				
Jc-1	11	10	11	7.9	2.9	2.9	3.2	2.3	1.2	1.3	1.0	0.9	6.5	4.0	2.8	3.7	0.2	0.0	0.0	0.0
J-7	10	7.2	10	5.9	13	17	8.8	4.2	2.8	3.4	1.6	1.1	17	20	9.8	5.8	0.2	0.2	0.0	0.0
J-8	8.2	4.4	10	5.3	12	17	8.3	4.3	2.8	3.1	1.5	1.1	15	19	9.2	6.7	0.2	0.2	0.1	0.0
Jfl-1	11	9.0	8.5	7.4	2.9	5.0	4.2	3.0	1.3	1.2	0.6	0.9	6.0	5.4	4.8	4.3	0.1	0.0	0.2	0.0
Jfl-2		9.0	6.5	6.0		3.2	2.5	2.3		1.1	0.7	1.0		3.5	4.0	3.8		0.2	0.2	0.0

DATES STREAMS WERE SAMPLED

STREAM	STATION	SUMMER	FALL	WINTER	SPRING
James River	J-1 through 8	8-(3-5-6)-64	10-(19-20-21)-64	1-(18-19-20)-65	4-(27-28-29)-65
Pearson Creek	Jp-1	8-5-64	10-20-64	1-18-65	4-27-65
Sequiota	Js-1	8-4-64	10-19-64	1-19-65	4-27-65
Rader Spring	Jwsp-1	8-4-64	10-20-64	1-19-65	4-28-65
Wilson Creek	Jw-1,2	8-4-64	10-(20-21)-64	1-19-65	4-28-65
Finley Creek	Jf-1 through 4	8-20-64	10-11-(19-5)-64	2-1-65	5-3-65
Crane Creek	Jc-1	8-6-64	10-21-64	1-20-65	4-29-65
Flat Creek	Jfl-1,2	8-(6-19)-64	11-(4-5)-64	2-(1-2)-65	5-(3-4)-65

TABLE II

SPRING RIVER BASIN WATER QUALITY DATA

	Air Temp. °C				Flow in cfs				Water Temp. °C				Dissolved Oxygen ppm				Dissolved Oxygen % Saturation			
Station	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.
S-1	25	12	18	28	4.6	4.1	12.4	16.9	21	11	16	19	11.5	11.5	11.9	11.8	128	104	119	126
S-2	25	12	18	28	4.7	4.8	18.1	19.1	20	7	15	20	8.6	12.3	12.0	11.3	130	101	111	123
S-3	25	12	19	26	5.0	5.1	23.3	29.6	21	5	14	21	10.3	13.1	16.4	9.7	114	102	158	108
Sh-1	23	15	22	27	1.4	2.9	8.3	23.8	20	5	12	23	8.8	14.8	13.0	9.5	96	116	120	109
Sw-1	21	15	19	26	5.8	7.0	14.8	12.9	22	11	13	23	4.9	11.9	14.0	10.1	56	107	132	116
S-4	23	14	22	20	48.5	53.7	174	187	18	9	13	18	8.6	15.6	12.8	8.4	91	134	121	88
S-5	24	11	8	21	52.6	67.6	232	265	20	6	12	19	8.6	15.6	11.4	8.6	93	93	106	92
S-6	25	-7	5	23	58.0	80.0	247	302	22	2	11	22	9.4	11.9	10.5	8.0	107	86	95	91
S-7	25	-7	3	28	67.0	86.0	256	306	22	2	11	24	9.0	14.4	11.1	8.2	102	104	100	96
Snf-2	24	-9	-5	30	0.3	*0.5	79	*0.1	22	1	6	31	4.5	7.4	10.1	8.4	51	52	81	112
Snf-3	24	-8	4	31	2.0	*6.0	*790	2.0	22	2	9	31	9.0	11.9	9.7	9.7	102	88	84	129
S-8	23	-8	4	26	62.0	95.0	1050	1070	23	2	10	23	9.0	14.8	9.5	7.8	103	107	94	90
Sc-1	29	1	8	28	17.1	20.3	24.6	50.4	22	5	8	20	7.8	13.2	13.1	9.9	89	103	110	108
Sc-2	29	1	8	29	21.4	21.3	23.2	62.1	22	4	7	22	7.8	13.2	15.6	10.1	89	101	128	115
Sc-3	31	0	5	25	34.2	41.4	39.5	110	25	4	7	23	7.8	13.2	14.4	8.2	93	101	118	94
Sc-4	32	6	5	25	44.0	45.0	43.1	110	26	2	-	24	7.4	12.0	15.6	7.1	90	89	128	84
Sc-5	28	7	2	23	40.7	50.3	47.2	110	25	3	5	23	6.6	12.0	15.6	6.3	79	89	122	72
Sc-6	29	9	4	28	50.4	60.1	52.1	127	26	4	5	23	6.2	12.0	14.4	5.3	76	92	113	61
Sc-7	31	7	5	28	52.0	86.0	57.6	137	27	4	5	23	7.4	11.6	13.9	6.3	91	89	109	72
Sc-8	33	4	7	30	54.8	59.0	58.2	147	28	45	5	23	8.6	12.0	13.9	7.6	108	92	109	87
St-9	31	10	2	30	33.0	15.0	12.6	32.0	26	9	6	25	6.6	7.6	7.0	9.0	80	66	56	107
Ss-3	23	8	12	29	38.8	41.2	63.7	108	24	5	9	23	9.4	11.5	13.1	9.7	111	90	113	111
Ss-4	21	11	11	29	53.9	55.1	99.1	155	24	5	8	25	8.2	12.3	14.4	8.4	90	96	124	100
Ss-10	29	11	10	30	125	115	116	250	26	5	8	26	7.8	12.0	13.9	8.6	95	94	117	105

*Estimated

DATES STREAMS WERE SAMPLED

STREAM	STATION	SUMMER	FALL	WINTER	SPRING
Shoal Creek	Ss-3,4,10	8-31-64	12-(2-16)-64	2-17-64	2-(23-24)-65
Center Creek	Sc-1 through 8	9-(1-2)-64	11-12-(30-1)-64	2-(16-17)-65	6-(22-23)-65
Spring River	S-1 through 8	9-(14-15)-64	12-(15-16-17)-64	3-(16-17)-65	5-6-(31-1)-65
Williams Creek	Sw-1	9-17-64	12-15-64	3-16-65	5-31-65
Honey Creek	Sh-1	9-17-64	12-16-64	3-16-65	5-31-65
North Fork Spring River	Snf-2,3	9-16-64	12-17-64	3-(17-18)-65	8-9-65
Turkey Creek	St-9	9-2-64	12-2-64	2-18-65	6-23-65

TABLE II

SPRING RIVER BASIN WATER QUALITY DATA

	p^H				Phth. Alk. as $CaCO_3$				Total Alkalinity as $CaCO_3$ ppm				Mg. Hardness as $CaCO_3$ ppm				Calcium Hardness as $CaCO_3$ ppm				Spec. Cond. micromhos/cm			
Station	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.
S-1	7.9	8.0	7.9	7.6	0	0	0	0	144	153	116	113	8	10	2	0	145	151	114	119	280	300	225	250
S-2	8.0	8.0	7.8	8.0	0	0	0	0	114	148	103	119	9	8	10	5	143	147	103	119	280	300	225	250
S-3	8.2	8.2	8.2	8.1	0	0	0	0	135	148	108	115	8	12	2	7	130	149	116	121	260	300	225	250
Sh-1	8.3	8.6	8.1	8.3	4	13	0	2	144	151	119	140	5	10	14	3	143	145	124	138	280	300	250	275
Sw-1	7.7	8.0	8.7	8.9	0	0	11	18	180	160	110	164	20	14	15	19	143	143	116	128	390	330	250	300
S-4	7.5	8.6	7.9	7.6	0	7	0	0	146	148	112	115	10	13	5	2	140	142	116	131	300	300	250	250
S-5	7.8	8.7	7.6	7.8	0	11	0	0	148	146	122	121	10	18	18	12	143	133	121	119	300	300	250	250
S-6	8.0	7.8	LA	LA	0	0	LA	LA	148	149	LA	LA	10	10	17	12	143	145	126	124	300	300	250	250
S-7	7.9	8.2	7.8	8.1	0	0	0	0	148	148	126	121	7	10	22	10	143	145	126	126	300	300	300	250
Snf-2	7.2	7.1	6.9	8.0	0	0	0	0	65	88	34	84	15	18	42	2	55	92	59	87	220	450	220	275
Snf-3	7.6	7.5	6.6	8.3	0	0	0	0	70	59	25	131	18	18	43	19	65	94	44	145	170	280	150	300
S-8	8.1	8.2	LA	8.1	0	0	LA	0	142	133	LA	128	15	14	27	17	138	141	79	119	300	300	200	250
Sc-1	8.0	8.0	7.8	8.1	0	0	0	0	113	122	137	90	8	6	27	17	130	124	124	114	250	250	260	225
Sc-2	8.0	8.0	8.2	8.2	0	0	0	0	135	126	131	116	10	7	8	5	130	128	131	111	250	250	260	240
Sc-3	8.1	8.0	LA	8.1	0	0	LA	0	128	128	LA	110	13	13	19	10	125	128	126	111	240	220	250	225
Sc-4	6.9	7.2	7.1	7.4	0	0	0	0	67	101	97	92	35	9	29	12	175	179	171	116	520	450	500	300
Sc-5	7.3	7.4	7.2	7.4	0	0	0	0	68	101	92	90	30	2	14	13	170	178	163	128	520	410	450	300
Sc-6	7.3	7.4	7.3	7.3	0	0	0	0	72	95	90	84	23	0	30	20	195	206	186	143	550	500	500	350
Sc-7	7.4	7.4	7.3	7.5	0	0	0	0	70	108	88	92	15	8	25	12	255	245	228	173	600	570	550	400
Sc-8	7.6	7.6	7.4	7.8	0	0	0	0	54	113	88	80	15	24	6	7	253	247	249	183	600	580	600	400
St-9	7.9	7.5	7.4	7.7	0	0	0	0	164	183	187	144	10	6	4	5	300	302	290	235	670	750	700	550
Ss-3	8.0	8.0	8.2	8.2	0	0	0	0	128	132	117	118	10	19	15	10	118	122	118	111	240	240	220	225
Ss-4	8.0	8.1	8.1	8.0	0	0	0	0	130	137	122	112	11	12	19	17	117	129	122	111	250	250	250	225
Ss-10	8.7	8.0	8.7	8.3	14	0	7	4	142	135	124	118	11	13	13	5	117	129	124	114	240	270	240	225

DATES STREAMS WERE SAMPLED

STREAM	STATION	SUMMER	FALL	WINTER	SPRING
Shoal Creek	Ss-3,4,10	8-31-64	12-(2-16)-64	2-17-64	2-(23-24)-65
Center Creek	Sc-1 through 8	9-(1-2)-64	11-12-(30-1)-64	2-(16-17)-65	6-(22-23)-65
Spring River	S-1 through 8	9-(14-15)-64	12-(15-16-17)-64	3-(16-17)-65	5-6-(31-1)-65
Williams Creek	Sw-1	9-17-64	12-15-64	3-16-65	5-31-65
Honey Creek	Sh-1	9-17-64	12-16-64	3-16-65	5-31-65
North Fork Spring River	Snf-2,3	9-16-64	12-17-64	3-(17-18)-65	8-9-65
Turkey Creek	St-9	9-2-64	12-2-64	2-18-65	6-23-65

TABLE II

SPRING RIVER BASIN WATER QUALITY DATA

	Ammonia as N ppm				Nitrate as N ppm				Nitrite as N ppm				Orthophosphate as PO_4 ppm			
Station	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.
S-1	0.35	0.30	0.45	0.60	2.2	2.5	2.2	2.7	0.015	0.015	0.005	0.005	0.28	0.09	0.09	0.00
S-2	0.90	0.70	0.45	1.0	2.0		2.5	0.1	0.025	0.010	0.007	0.008		<0.2+	<0.2+	<0.2+
S-3	0.70	0.80	<0.10	0.60	1.2	1.9	1.9	2.2	0.010	0.030	0.015	0.015	0.26	0.04	0.21	0.06
Sh-1	0.70	0.30	0.45	0.20			6.0	0.4	0.005	0.005	0.015	0.015	0.19		0.20	0.20
Sw-1	1.2	0.70	0.35	2.2			0.2	2.0	0.160	0.150	0.035	0.070				3.0+
S-4	0.35	0.45	0.40	0.60	1.9	2.3	2.3	2.5	0.005	0.010	0.010	0.015	0.20	0.39	0.68	0.09
S-5	0.35	0.40	0.45	0.80	1.4	1.6	2.7	2.2	0.005	0.005	0.015	0.005	0.16	0.10	0.14	0.03
S-6	0.70	0.70	0.45	0.80	1.2	1.6	2.1	0.1	0.015	0.007	0.025	0.015	0.55	0.44	0.19	0.07
S-7	0.35	0.20	0.30	0.40	0.9	0.9	2.2	0.4	0.005	0.007	0.040	0.015	0.50	0.25	0.49	0.04
Snf-2	0.55	2.5	0.90	0.90	0.3			0.1	0.007	0.030	0.025	<0.005	0.3+			<0.2+
Snf-3	0.55	0.25	1.0	1.2	0.2	0.1	3.7	0.2	0.015	0.005	0.015	<0.005	0.20	0.03	0.42	0.15
S-8	0.80	0.20	0.45	0.70	0.7	0.1	1.4	2.2	0.010	0.000	0.025	0.015	0.54	0.09	0.23	0.11
Sc-1	0.25	0.45	0.55	1.0	1.2	2.9	2.5	2.7	0.005	0.005	0.015	0.005	0.04	0.80	0.29	0.00
Sc-2	0.45	0.45	0.70	0.60	2.0	2.0	4.0		0.005	0.005	0.015	0.005	<0.2		0.3+	<0.2+
Sc-3	0.35	0.70	0.45	0.30	0.8	2.5	1.6	1.9	0.005	0.005	0.015	0.005	0.06	0.04	0.38	0.14
Sc-4	11	7.0	15	2.0	10.8	8.6	11.1	4.0	0.150	0.060	0.750	0.300	19	16	22	18
Sc-5	10	6.0	14	3.0	10.8	7.2	10.8	6.7	0.300	0.060	0.125	0.600	16	12	16	3.6
Sc-6	10	8.0	14	1.6	8.1	9.0	10.0	7.4	0.300	0.070	0.095	0.700	19	16	16	3.3
Sc-7	8.0	8.0	10	1.3	10.0	8.0	15.0	6.2	0.350	0.070	0.110	0.350	16		10	
Sc-8	4.5	16	4.5	1.1	9.5	12.0	8.1	1.5	0.600	0.060	0.300	0.150	9.3	8.4	17	3.2
St-9	0.25	2.5	5.0	1.6				<0.1	0.150			0.150			20	6.0
Ss-3	0.55	0.35	0.35	0.90				2.0	0.005+			0.005			<0.2+	0.2+
Ss-4	0.35	0.25	0.70	1.2				2.0	0.005			0.005				1.8+
Ss-10	0.35	0.45	0.55	0.40	0.1	3.2	6.9	4.7	0.005	0.005	0.015	0.005	0.48	0.04	0.52	0.16

+ Field Data

DATES STREAMS WERE SAMPLED

STREAM	STATION	SUMMER	FALL	WINTER	SUMMER
Shoal Creek	Ss-3,4,10	8-31-64	12-(2-16)-64	2-17-64	2-(23-24)-65
Center Creek	Sc-1 through 8	9-(1-2)-64	11-12-(30-1)-64	2-(16-17)-65	6-(22-23)-65
Spring River	S-1 through 8	9-(14-15)-64	12-(15-16-17)-64	3-(16-17)-65	5-6-(31-1)-65
Williams Creek	Sw-1	9-17-64	12-15-64	3-16-65	5-31-65
Honey Creek	Sh-1	9-17-64	12-16-64	3-16-65	5-31-65
North Fork Spring River	Snf-2,3	9-16-64	12-17-64	3-(17-18)-65	8-9-65
Turkey Creek	St-9	9-2-64	12-2-64	2-18-65	6-23-65

TABLE II
SPRING RIVER BASIN WATER QUALITY DATA

Station	Detergents as ABS ppm				Coliform Bacteria per 100 ml.				Fecal Streptococcus per 100 ml.				Turbidity Units			
	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.
S-1	0.0	0.0	0.0	0.0	41	110	300	480	56	6	2	34	7	<5	<5	<5
S-2					310	62	90	530	110	40	4	58	7	5	<5	8
S-3	0.1	0.0	0.0	0.0	340	12	1000	840	200	140	20	40	9	<5	<5	8
Sh-1					120	4	80	400	84	44	18	42	15	<5	10	<5
Sw-1					600	10000	46000	10000	40	1100	360	4300	5	<5	<5	8
S-4	0.0	0.0	0.1	0.0	63	34	120	140	264	12	8	70	19	<5	< 5	29
S-5	0.0	0.0	0.0	0.0	24	14		LA	120	10		340	19	<5	<5	29
S-6	0.1	0.0	0.1	0.0	27000	10000	11000	360	110	1200	320	370	24	<5	10	24
S-7	0.1	0.0	0.2	0.1	40	12	2400	270	72	2	190	320	14	<5	5	31
Snf-2					200	18	3000	5300	84	10	2100	24	65	15	500	29
Snf-3	0.0	0.0	1.8	0.0	8	80	1500	260	10	160	2000	12	60	25	950	20
S-8	0.1	0.1	1.0	0.0	8	2	2	300	46	34	2200	210	19	<5	700	LA
Sc-1	0.0	0.0	0.1	0.0	800	38	6	120	300	100	24	100	18	5	<5	< 5
Sc-2					450	<2	16	46	320	60	2	68	17	<5	<5	6
Sc-3	0.0	0.0	0.0	0.0	450	18	6	180	440	80	4	84	22	<5	10	8
Sc-4	0.1	0.2	0.1	0.1	310	32	8	200	140	56	4	94	24	5	14	10
Sc-5	0.2	0.1	0.3	0.1	50	2	6	90	130	10	4	110	5	<5	<5	6
Sc-6	0.2	0.1	0.1	0.1	200	<2	66	250	50	42	16	66	5	5	<5	<5
Sc-7					100	<2	8	240	36	4	12	72	7	<5	5	<5
Sc-8	0.2	0.1	0.1	0.1	16	2	<2	140	140	10	2	26	11	<5	6	5
St-9					NG	11000	67000	88000	130	4000	570	350	8	<5	6	6
Ss-3					30	<50	2	180	600	<50	<2	140	7	<5	<5	<5
Ss-4					90	<50	2	190	160	<50	6	7000	13	<5	<5	10
Ss-10	0.1	0.0	0.1	0.0	60	600	12	300	80	400	<2	100	15	<5	<5	8

DATES STREAMS WERE SAMPLED

STREAM	STATION	SUMMER	FALL	WINTER	SPRING
Shoal Creek	Ss-3,4,10	8-31-64	12-(2-16)-64	2-17-64	2-(23-24)-65
Center Creek	Sc-1 through 8	9-(1-2)-64	11-12-(30-1)-64	2-(16-17)-65	6-(22-23)-65
Spring River	S-1 through 8	9-(14-15)-64	12-(15-16-17)-64	3-(16-17)-65	5-6-(31-1)-65
Williams Creek	Sw-1	9-17-64	12-15-64	3-16-65	5-31-65
Honey Creek	Sh-1	9-17-64	12-16-64	3-16-65	5-31-65
North Fork Spring River	Snf-2,3	9-16-64	12-17-64	3-(17-18)-65	8-9-65
Turkey Creek	St-9	9-2-64	12-2-64	2-18-65	6-23-65

TABLE II

SPRING RIVER BASIN WATER QUALITY DATA

	Color				Iron as Fe ppm				Manganese as Mm ppm				Sulfate as SO_4 ppm			
Station	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.
S-1	2	2	3	11	0.04	0.02	0.04	0.05	0.00	0.00	0.00	0.00	2.8	4.0	4.0	2.8
S-2																
S-3	4	5	0	11	0.03	0.10	0.03	0.06	0.00	0.00	0.00	0.00	4.2	4.4	7.4	8.0
Sh-1																
Sw-1																
S-4	5	2	2	10	0.00	0.01	0.03	0.15	0.00	0.00	0.01	0.00	7.8	8.4	8.6	6.8
S-5	5	2	1	12	0.04	0.02	0.08	0.19	0.00	0.00	0.00	0.00	7.2	7.4	9.2	7.6
S-6	5	1	2	8	0.00	0.14	0.10	0.48	0.00	0.00	0.00	0.00	8.8	9.4	10	8.4
S-7	6	4	1	8	0.02	0.03	0.06	0.38	0.00	0.00	0.00	0.00	10	11	13	8.8
Snf-2																
Snf-3	10	10	50		0.38	0.62	1.90	0.32	0.00	0.00	0.00	0.01	21	81	55	41
S-8	5	5	22	11	0.00	0.22	0.77	0.55	0.00	0.00	0.00	0.00	11	34	49	14
Sc-1	25	3	1	11	0.04	0.10	0.02	0.02	0.00	0.00	0.00	0.00	3.2	5.6	5.2	5.0
Sc-2																
Sc-3	7	2	1	13	0.00	0.06	0.04	0.05	0.00	0.00	0.00	0.00	5.6	8.0	6.8	7.0
Sc-4	5	3	2	12	0.00	0.05	0.22	0.10	0.01	0.60	0.00	0.00	93	80	84	26
Sc-5	9	2	4	6	0.03	0.06	0.10	0.10	0.01	0.00	0.10	0.00	92	66	76	28
Sc-6	5	4	1	5	0.00	0.07	0.11	0.00	0.70	0.04	0.40	0.00	118	110	104	71
Sc-7																
Sc-8	5	3	1	6	0.00	0.06	0.06	0.00	0.01	0.00	0.30	0.00	175	146	160	88
St-9																
Ss-3																
Ss-4																
Ss-10	5	1	1	6	0.03	0.02	0.02	0.00	0.00	0.00	0.01	0.00	9.6	12	8.6	9.0

DATES STREAMS WERE SAMPLED

STREAM	STATION	SUMMER	FALL	WINTER	SPRING
Shoal Creek	Ss-3,4,10	8-31-64	12-(2-16)-64	2-17-64	2-(23-24)-65
Center Creek	Sc-1 through 8	9-(1-2)-64	11-12-(30-1)-64	2-(16-17)-65	6-(22-23)-65
Spring River	S-1 through 8	9-(14-15)-64	12-(15-16-17)-64	3-(16-17)-65	5-6(31-1)-65
Williams Creek	Sw-1	9-17-64	12-15-64	3-16-65	5-31-65
Honey Creek	Sh-1	9-17-64	12-16-64	3-16-65	5-31-65
North Fork Spring River	Snf-2,3	9-16-64	12-17-64	3-(17-18)-65	8-9-65
Turkey Creek	St-9	9-2-64	12-2-64	2-18-65	6-23-65

TABLE II
SPRING RIVER BASIN WATER QUALITY DATA

	Silica as SiO_2 ppm				Sodium as Na ppm				Potassium as K ppm				Chloride as Cl^- ppm				Flouride as F^- ppm			
Station	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.
S-1	9.4	9.8	9.9	9.8	4.3	4.7	3.8	3.8	0.9	0.8	0.4	0.7	8.0	8.3	6.0	6.9	0.1	0.0	0.1	0.0
S-2																				
S-3	9.1	8.6	8.5	9.3	4.2	5.0	4.3	4.9	1.0	1.0	0.8	1.1	8.0	12.0	8.0	8.6	0.1	0.0	0.2	0.0
Sh-1																				
Sw-1																				
S-4	8.5	5.9	7.7	9.6	6.0	6.0	4.4	4.1	1.3	1.1	0.6	1.0	8.0	8.2	5.7	6.4	0.0	0.1	0.2	0.0
S-5	10	2.5	8.3	9.6	5.3	5.5	4.1	3.8	1.3	1.1	0.6	1.0	6.0	6.8	5.5	5.8	0.0	0.0	0.2	0.0
S-6	9.1	2.1	8.0	9.9	6.2	6.2	4.4	4.2	1.5	1.2	0.7	1.0	8.0	7.3	6.0	5.6	0.0	0.0	0.2	0.1
S-7	9.2	0.7	8.1	10	6.4	6.5	4.9	4.2	1.7	1.1	0.8	1.1	8.0	8.0	6.4	5.7	0.0	0.0	0.2	0.0
Snf-2																				
Snf-3	6.6	8.5	6.6	1.0	3.8	12	7.5	8.8	3.4	5.6	4.5	3.2	0.1	6.6	3.6	6.0	0.2	0.1	0.4	0.1
S-8	8.8	1.7	6.7	10	6.8	7.9	7.6	4.5	1.8	1.6	3.4	1.3	9.0	7.7	4.4	5.6	0.1	0.0	0.4	0.1
Sc-1	10	9.9	8.5	9.1	3.7	3.8	4.0	3.6	1.0	0.8	0.4	0.8	4.0	5.1	5.3	5.4	0.0	0.0	0.2	0.2
Sc-2																				
Sc-3	9.0	8.4	5.9	8.5	3.6	3.9	4.1	3.6	1.4	1.1	0.5	0.9	3.0	4.9	4.9	4.3	0.0	0.0	0.2	0.2
Sc-4	26	24	18	14	14	9.8	13	6.2	2.6	1.6	1.1	1.2	9.0	7.1	8.9	5.4	30	3.0	16	9.3
Sc-5	28	20	16	13	13	8.6	12	7.6	2.5	1.6	1.0	1.4	10	8.6	10	5.6	28	16	15	6.8
Sc-6	20	21	16	13	11	9.8	12	8.0	2.4	1.7	1.2	1.3	9.0	8.9	8.7	5.0	17	15	15	6.8
Sc-7													14.0							
Sc-8	17	18	15	13	12	11	13	6.6	2.4	2.0	1.4	1.6	9.0	8.3	9.5	4.9	13	4.0	13	6.0
St-9																				
Ss-3																				
Ss-4																				
Ss-10	10	8.6	4.5	9.8	4.5	5.0	4.1	4.1	1.7	1.2	0.6	1.1	5.0	4.7	5.1	3.8	0.0	0.1	0.3	0.2

DATES STREAMS WERE SAMPLED

STREAM	STATION	SUMMER	FALL	WINTER	SPRING
Shoal Creek	Ss-3,4,10	8-31-64	12-(2-16)-64	2-17-64	2-(23-24)-65
Center Creek	Sc-1 through 8	9-(1-2)-64	11-12-(30-1)-64	2-(16-17)-65	6-(22-23)-65
Spring River	S-1 through 8	9-(14-15)-64	12-(15-16-17)-64	3-(16-17)-65	5-6-(31-1)-65
Williams Creek	Sw-1	9-17-64	12-15-64	3-16-65	5-31-65
Honey Creek	Sh-1	9-17-64	12-16-64	3-16-65	5-31-65
North Fork Spring River	Snf-2,3	9-16-64	12-17-64	3-(17-18)-65	8-9-65
Turkey Creek	St-9	9-2-64	12-2-64	2-18-65	6-23-65

TABLE III

ELK RIVER BASIN WATER QUALITY DATA

	Air Temp. °C				Flow in cfs				Water Temp. °C				Dissolved Oxygen ppm				Dissolved Oxygen % Saturation			
Station	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.
Ebs-1	30	24	-4	25	8.5	10.5	31.4	77.6	26	18	3	17	10.3	11.6	15.2	12.0	126	122	116	124
Els-1	26	24	-1	25	6.6	16.1	36.4	94.4	24	17	4	17	7.8	11.2	14.4	12.0	92	115	113	124
E-1	29	24	1	27	34.9	44.4	114	277	25	17	5	19	8.6	9.6	13.9	11.6	102	99	111	123
Ei-1	30	25	6	27	44.2	32*	48.2	142	25	18	4	22	9.8	10.8	13.9	12.6	117	114	106	143
Ei-2	31	26	1	28	46.8	33.5	48.4	157	26	18	4	22	9.0	10.4	15.6	12.8	110	109	119	145
E-2	28	22	1	21	89.2	78*	166	423	24	18	5	21	8.2	10.8	14.0	11.8	96	114	112	131
E-3	32	22	-3	19	152	140	187	480	25	18	3	21	9.0	10.4	13.1	10.9	107	109	97	146
B-1	28	22	2	23	8.8	4.5	14.1	35.9	22	18	6	18	7.4	6.8	14.8	11.3	84	72	118	119

	p^H				Phth. Alk. as $CaCO_3$ ppm				Total Alkalinity as $CaCO_3$ ppm				Mg. Hardness as $CaCO_3$ ppm				Calcium Hardness as $CaCO_3$ ppm				Specific Cond. micromhos/cm			
Station	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.
Ebs-1	8.2	8.2	8.1	8.3	0	0	0	2	124	150	140	113	6	12	10	20	120	133	137	106	230	260	250	190
Els-1	7.9	8.2	8.0	8.3	0	0	0	2	133	155	142	113	4	10	2	14	132	143	139	107	240	280	250	
E-1	8.1	8.0	7.8	8.2	0	0	0	0	135	146	131	115	12	13	11	7	128	128	128	109	260	250	250	220
Ei-1	8.2	8.1	7.9	8.5	0	0	0	4	112	131	108	97	10	12	8	5	112	119	110	96	220	230	220	190
Ei-2	8.1	8.1	8.3	8.5	0	0	2	4	112	133	115	101	8	11	12	10	116	120	114	94	230	230	200	210
E-2	8.0	8.1	8.2	8.4	0	0	0	2	121	137	133	103	12	14	2	10	120	129	121	101	240	230	250	200
E-3	8.2	8.1	7.8	8.2	0	0	0	0	121	135	135	110	8	13	13	24	118	120	126	101	230	240	240	200
B-1	7.6	7.6	7.7	7.7	0	0	0	0	122	135	112	101	4	7	13	8	124	132	116	101	250	260	220	200

*Estimated

DATES STREAMS WERE SAMPLED

STREAM	STATION	SUMMER	FALL	WINTER	SPRING
Big Sugar Creek	Ebs-1	8-17-64	11-4-64	2-2-65	5-4-65
Little Sugar Creek	Els-1	8-17-64	11-4-64	2-2-65	5-4-65
Elk River	E-1 through 3	8-19-64	11-(3-4)-64	2-(2-3)-65	5-(4-5)-65
Indian Creek	Ei-1,2	8-18-64	11-3-64	2-(2-3)-65	5-4-65
Buffalo Creek	B-1	8-18-64	11-4-64	2-3-65	5-5-65

TABLE III

ELK RIVER BASIN WATER QUALITY DATA

	Ammonia as N ppm				Nitrite as N ppm				Nitrate as N ppm				Orthophosphate as PO_4 ppm			
Station	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.
Ebs-1	0.35	0.90	0.25	0.45	0.000	0.005	<0.005	0.005	0.4	0.1	1.1	1.3	0.07	0.04	0.13	0.00
Els-1	0.25	0.30	0.45	0.45	0.000	<0.005	<0.005	0.008	0.5	0.3	0.3	1.6	0.12	0.01	0.18	0.06
E-1	0.35	0.40	0.25	0.45	<0.005	0.000	<0.005	0.005	0.5	0.2	0.6	1.4	0.05	0.00	0.11	0.00
Ei-1	0.25	0.70	0.35	0.45	0.000	0.005	<0.005	0.005	1.1	0.4	1.8	2.0	0.09	0.00	0.17	0.01
Ei-2	0.45	0.30	0.30	0.70	0.005	0.007	<0.005	0.010	0.7	0.2	0.8	1.8	0.14	0.14	0.08	0.08
E-2	0.25	0.45	0.30	0.45	0.000	0.000	0.007	0.005	0.1	0.6	0.2	1.2	0.09	0.02	0.08	0.00
E-3	0.55	0.55	0.35	0.35	0.000	0.005	<0.005	0.005			0.9	1.5				<0.2+
B-1	0.25	0.70	0.45	0.35	0.000	0.000	<0.005	0.005	0.7	0.2	1.0	1.2	0.02	0.00	0.22	0.03

	Detergents as ABS ppm				Coliform Bacteria per 100 ml.				Fecal Strep. per 100 ml.				Turbidity Units				Color			
Station	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.
Ebs-1	0.0	0.0	0.0	0.0	35	<2	26	150		46	6	60	<5	<5	<5	6	5	7	1	1
Els-1	0.0	0.0	0.0	0.0	200	10	<2	78		40	<2	84	6	<5	<5	10	5	5	0	0
E-1	0.0	0.0	0.0	0.0	51	8	20	116	50	20	<2	42	7	<5	<5	<5	5	5	0	1
Ei-1	0.0	0.0	0.0	0.0	26	12	2	42	38	40	4	24	8	<5	<5	<5	5	5	1	1
Ei-2	0.0	0.0	0.0	0.0	800	100	34	290	120	20	<2	30	17	<5	<5	<5	3	5	1	1
E-2	0.0	0.0	0.0	0.0	52	4	6	48	53	22	<2	92	5	<5	<5	<5	5	5	1	1
E-3	0.0	0.0	0.0	0.0	10	100	120	160	42	40	<2	38	10	<5	<5	<5				
B-1	0.0	0.0	0.0	0.0	42	94	12	110	91	4	6	46	7		<5	<5	4	3	0	2

+Field Data

DATES STREAMS WERE SAMPLED

STREAM	STATION	SUMMER	FALL	WINTER	SPRING
Big Sugar Creek	Ebs-1	8-17-64	11-4-64	2-2-65	5-4-65
Little Sugar Creek	Els-1	8-17-64	11-4-64	2-2-65	5-4-65
Elk River	E-1 through 3	8-19-64	11-(3-4)-64	2-(2-3)-65	5-(4-5)-65
Indian Creek	Ei-1,2	8-18-64	11-3-64	2-(2-3)-65	5-4-65
Buffalo Creek	B-1	8-18-64	11-4-64	2-3-65	5-5-65

TABLE III

ELK RIVER BASIN WATER QUALITY DATA

Station	Iron as Fe ppm				Manganese as Mm ppm				Sulfate as SO_4 ppm				Silica as SiO_2 ppm			
	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.
Ebs-1	0.01	0.01	0.02	0.00	0.00	0.01	0.00	0.00	7.8	7.2	8.0	6.4	11	9.5	6.6	8.1
Els-1	0.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00	5.0	9.0	6.6	8.4	13	11	7.4	5.8
E-1	0.02	0.01	0.02	0.00	0.00	0.01	0.00	0.00	6.8	7.0	8.0	7.4	12	9.4	6.8	6.8
Ei-1	0.00	0.05	0.01	0.00	0.00	0.00	0.00	0.00	3.4	3.6	4.2	5.0	11	9.6	7.4	6.1
Ei-2	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	4.0	4.4	5.0	5.2	11	10	6.7	5.6
E-2	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	6.2	6.4	7.6	7.0	11	9.4	6.7	6.5
E-3																
B-1	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	6.8	8.4	7.8	8.6	12	12	7.7	7.9

Station	Sodium as Na ppm				Potassium as K ppm				Chloride as Cl^- ppm				Flouride as F^- ppm			
	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.	S.	F.	W.	S.
Ebs-1	2.6	3.0	2.3	3.4	1.4	1.3	0.7	1.2	4.0	3.8	3.2	4.2	0.0	0.2	0.2	0.0
Els-1	5.8	6.5	5.2	2.3	2.0	1.9	1.3	1.0	8.0	7.4	7.0	2.8	0.0	0.3	0.2	0.0
E-1	3.2	4.1	3.4	2.8	1.5	1.4	0.8	1.2	4.0	5.0	4.7	3.9	0.0	0.2	0.1	0.0
Ei-1	2.9	3.2	2.9	2.8	1.2	1.1	0.5	1.0	3.0	4.1	3.2	2.8	0.0	0.2	0.1	0.0
Ei-2	3.3	3.9	3.3	2.9	1.3	1.4	0.8	1.2	5.0	4.1	3.7	3.6	0.0	0.2	0.2	0.0
E-2	3.3	3.9	3.3	2.6	1.5	1.4	0.8	1.1	4.0	3.7	4.1	3.4	0.0	0.2	0.2	0.0
E-3																
B-1	4.2	4.7	4.0	3.5	1.5	1.4	0.7	1.2	6.0	7.0	7.1	5.4	0.0	0.2	0.1	0.0

DATES STREAMS WERE SAMPLED

STREAM	STATION	SUMMER	FALL	WINTER	SPRING
Big Sugar Creek	Ebs-1	8-17-64	11-4-64	2-2-65	5-4-65
Little Sugar Creek	Els-1	8-17-64	11-4-64	2-2-65	5-4-65
Elk River	E-1 through 3	8-19-64	11-(3-4)-64	2-(2-3)-65	5-(4-5)-65
Indian Creek	Ei-1,2	8-18-64	11-3-64	2-(2-3)-65	5-4-65
Buffalo Creek	B-1	8-18-64	11-4-64	2-3-65	5-5-65